VLPR·2012
SHANGHAI

The USA-Sino Summer School in

Vision, Learning and Pattern Recognition

Shanghai, China

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Introduction

The theme of VLPR 2012 complements the methodology-centered themes in previous summer schools with an application-oriented and human-centered theme, focusing on life forms of drastically different scales: from human and animals (macro) to cells (micro). Contrary to narrowing down on specific computer vision technologies, we aim to demonstrate a cross sectional state of the art computer vision and machine learning methodologies, to broaden our horizon for innovations and creativities and to address some fundamental issues of high throughput computing on multi-modality, high-dimensional, high volume image data (Big Data).

Scientific Exchange

The theme of this summer school reflects the growing international trend of interdisciplinary research in biomedical image and smart health, and facilitates collaborative efforts between science and technology, computer science and medicine/biology, and US and China. Not simply a series of lectures, VLPR 2012 also offers the opportunity to meet researchers in biomedical image research from the U.S. and China. With the growing American-Chinese technology collaborations, VLPR summer school 2012 at Fudan University provides a great platform of information exchange, in-depth discussions and professional networking for the researchers and students alike.

Cultural Exchange - China and the USA

Experience not just the academic side of China, but also the cultural and social side with Shanghai's wide array of attractions, both the very ancient and the very modern. VLPR 2012 program includes a full-day social activity and an evening gala showing off students and speakers respective talents.

Broader Impact

The theme of this summer school echos the growing international trend of interdisciplinary research in biomedical image and smart health, and facilitates collaborative efforts between science and technology, computer science and medicine/biology, and US and China. In addition, this summer school offers a great opportunity for intellectual and cultural exchanges between a group of world-class researchers and motivated students from the two countries to mingle with each other in an exciting, culturally rich environment during a week-long period.

Objectives and Topics

The summer school will provide a venue and a platform for the participants to explore a wide yet coherent range of computer vision applications in biomedical domains, with a theme on life sciences and smart health. The participants will be exposed to a variety of computer vision applications, challenges and solutions leveraged by some advanced techniques, which will be presented by a group of research leaders in the field. Topics include:

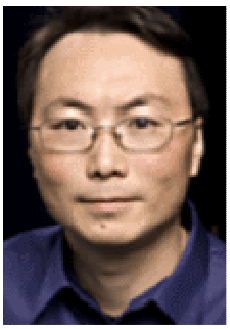
- Biomedical imaging/acquisition
- Human (animal, cell) crowd tracking, behavior modeling
- Machine learning for computer aided diagnosis
- Multimodality high-dimensional deformable registration (cross modality, cross subjects)
- Computational and Statistical Anatomy (Digital atlas)
- Shape analysis, Segmentation and Visualization
- Human (animal) gaits/mood, face/expression classification/recognition
- Large, multi-modal, multi-scale biomedical image database indexing and retrieval

Organization

VLPR 2012 Co-Directors

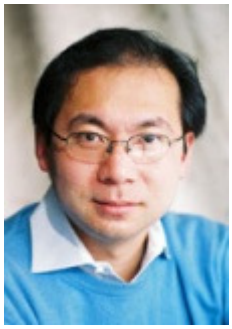
Dr. Yanxi Liu
Associate Professor
Co-Director: Laboratory for Perception, Action, and Cognition (LPAC)
The Pennsylvania State University

Dr. Charless C. Fowlkes
Assistant Professor, Dept. of Computer Science
Computational Vision Group
University of California, Irvine



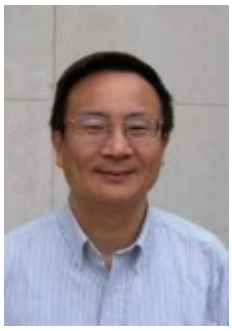
Dr. Hanchuan Peng
Senior Computer Scientist, Janelie Farm Research Campus
Howard Hughes Medical Institute (HHMI)

Advisory Board



Jianbo Shi
Associate Professor
University of Pennsylvania

Cheng-Lin Liu
Researcher
National Laboratory of Pattern Recognition (NLPR)
Chinese Academy of Sciences (CAS)



Hong Ma
Professor
School of Life Sciences
Fudan University

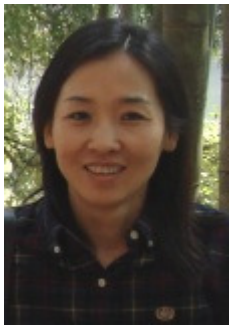
Song-Chun Zhu
Professor, Depts. of Statistics and Computer Science
University of California, Los Angeles

Xiaoyang (Sean) Wang
Professor and Dean
School of Computer Science,
Fudan University

Jie Yang
National Science Foundation (NSF)

Local Organizing Committee

Prof. Hongbo Yu
Professor
School of Life Sciences
Fudan University



Xiaohua Liang
Fudan University

Prof. Yan Qiu Chen
Professor
Computer Science and Technology
Fudan University

Jianbing Zhu
Fudan University

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Financial Manger (U.S.)
Budget Staff Assistant
The Pennsylvania State University

Lena Pipenberg
Financial Manager (U.S.)
Budget Support Staff Assistant
The Pennsylvania State University

Important Information

Location: The lecture room is located in Fudan Main Campus, in the 1st floor meeting room, in Yifu Building.

Contacts: Mr. Jianbing Zhu, 13601709428, jbzhu@fudan.edu.cn, General Inquiries
Mr. Wang Li, 15026678001, 10210700119@fudan.edu.cn, Accommodations
Mr. Lei Tong, 13816873026, Conference Room (Test PPT Presentations)

We will take a group photo on Monday, July 23, 9:30-10:00 am, during the Coffee Break

The Welcome Dinner is on Monday, July 23, 6:00 pm, at the second floor of the Qinyun Hotel. Service is buffet style, casual dress code.

The one day Suzhou Tour is on Thursday, July 26. We will meet at 7:00 am, at the main gate of Fudan University on Handan Rd.

All of the information is available online at: http://vision.cse.psu.edu/vlpr2012/vlpr2012.html

Speakers

Dr. Serge Belongie	Dr. Erik G. Learned-Miller	Dr. Hanchuan Peng
Dr. Margrit Betke	Dr. Yanxi Liu	Dr. Zhuowen Tu
Prof. Yan Qiu Chen	Prof. Hong Ma	Xiaohui Wu, Ph.D.
Dr. Robert Collins	Dr. Anant Madabhushi	Prof. Hongbo Yu
Dr. Charless Fowlkes	Dr. B. S. Manjunath	Tao P. Zhong, Ph.D.
Dr. Takeo Kanade	Dr. Tiehua Ni	

Dr. Serge Belongie

Professor, Computer Science and Engineering
University of California, San Diego

Topic: Visual Recognition With Humans in the Loop

Serge Belongie was born in Sacramento, California. He received the B.S. degree (with honor) in Electrical Engineering from the California Institute of Technology in 1995 and the M.S. and Ph.D. degrees in Electrical Engineering and Computer Sciences (EECS) at U.C. Berkeley in 1997 and 2000, respectively. While at Berkeley, his research was supported by a National Science Foundation Graduate Research Fellowship. He is also a co-founder of Digital Persona, Inc., and the principal architect of the Digital Persona fingerprint recognition algorithm. He is currently a Professor in the Computer Science and Engineering Department at U.C. San Diego. His research interests include computer vision and pattern recognition. He is a recipient of the NSF CAREER Award and the Alfred P. Sloan Research Fellowship. In 2004 MIT Technology Review named him to the list of the 100 top young technology innovators in the world (TR100).

Dr. Margrit Betke

Professor and Associate Chair, Department of Computer Science
Boston University

Topic: Seeing in the Dark - Unveiling the Flight Behavior of Gregarious Bats Using Thermal Imaging

Margrit Betke is a Professor of Computer Science at Boston University, where she co-leads the Image and Video Computing Research Group. She conducts research in computer vision, in particular, the development of methods for detection, segmentation, registration, and tracking of objects in visible-light, infrared, and x-

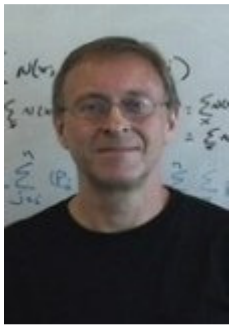
ray image data. She has worked on gesture, vehicle, and animal tracking, video-based human-computer interfaces, statistical object recognition, and medical imaging analysis. She has published over 80 original research papers. She earned her Ph.D. degree in Computer Science and Electrical Engineering at the Massachusetts Institute of Technology in 1995. Prof. Betke has received the National Science Foundation Faculty Early Career Development Award in 2001 for developing "Video-based Interfaces for People with Severe Disabilities." She co-invented the "Camera Mouse," an assistive technology used worldwide by children and adults with severe motion impairments. While she was a Research Scientist at the Massachusetts General Hospital and Harvard Medical School, she co-developed the first patented algorithms for detecting and measuring pulmonary nodule growth in computed tomography. She was one of two academic honorees of the "Top 10 Women to Watch in New England Award" by Mass High Tech in 2005. She currently leads a 5-year research program to develop intelligent tracking systems that reason about group behavior of people, bats, birds, and cells.

Prof. Yan Qiu Chen

Professor
Computer Science and Technology
Fudan University

Topic: Multi-view 3D Tracking of Particle System and Deforming Surface and Its Application to Biomedical Research.

Yan Qiu Chen received his Ph.D. from Southampton University, United Kingdom in 1995; and his M.Eng. and B.Eng. from Tongji University, Shanghai, China in 1988 and 1985 respectively. Dr. Chen is currently a full professor with School of Computer Science at Fudan University, Shanghai, China, and is a member of Fudan University Academic Committee, and chairman of Computer Science School Academic Committee. He had been Chairman of Department of Communication Science and Engineering from 2004 through 2007, and Associate Chairman of Department of Computer Science and Engineering from 2002 through 2004. Dr. Chen was an assistant professor with School of Electrical and Electronic Engineering of Nanyang Technological University, Singapore from 1996 through 2001; and was a postdoctoral research fellow with Glamorgan University, UK in 1995.



Dr. Robert Collins

Associate Professor
Co-Director: Laboratory for Perception, Action, and Cognition (LPAC)
The Pennsylvania State University

Topic: Video Tracking and Crowd Scene Analysis

Dr. Collins joined the faculty of CSE as an associate professor in spring 2005. Prior to joining CSE, he was an associate research professor at the Robotics Institute of Carnegie Mellon University. He received his Ph.D. in

computer science in 1993 from the University of Massachusetts in Amherst, MA, for work on scene reconstruction using stochastic projective geometry.

Dr. Collins is co-director of the Laboratory for Perception, Action, and Cognition (LPAC) in the CSE department. His research area is computer vision, with an emphasis on video scene understanding, automated surveillance, human activity modeling, and real-time tracking. From 1992 to 1996, he was technical director of the DARPA RADIUS project at UMass, which developed vision algorithms for recovering 3D site models from multiple, oblique aerial views. From 1996 to 1999, Dr. Collins was technical director of the DARPA Video Surveillance and Monitoring (VSAM) project at CMU, which demonstrated a real-time, automated multi-camera video surveillance system for monitoring the activities of people and vehicles in a complex scene. Dr. Collins developed video visualization tools and rapid camera calibration routines for the 30-camera EyeVision system, demonstrated during the live broadcast of Superbowl XXXV in January 2001. From 2002 to 2004, he was co-PI of the DARPA HumanID project, which explored new algorithms for biometric identification based on gait, non-frontal facial views, and facial expression. His current research is on real-time, appearance-based object tracking, with a special emphasis on tracking moving objects from moving camera platforms. This work has been used to perform surveillance from unmanned air vehicles (DARPA VIVID program, Co-PI) and to navigate an unmanned water vehicle in river and harbor environments (DARPA Mars2020 program, PI). Dr. Collins is PI of a current NSF grant on persistent tracking of objects in video and a Co-PI of a multi-disciplinary NSF grant for applying computer vision technology to analyze the social behavior of individuals and groups in crowds. He is an associate editor for the International Journal of Computer Vision.

Dr. Charless C. Fowlkes
Assistant Professor, Dept. of Computer Science
Computational Vision Group
University of California, Irvine

Topic: Automating Biological Image and Shape Analysis

Charless Fowlkes received a BS with honors from Caltech in 2000 and a PhD in Computer Science from the University of California, Berkeley in 2005, where his research was supported by a US National Science Foundation Graduate Research Fellowship. He is currently an Assistant Professor in the Department of Computer Science at the University of California, Irvine. His research interests are in computer and human vision, in particular how to combine bottom-up processing, such as image segmentation with top-down information, such as recognition of familiar shapes. He also works on developing tools for biological image analysis in order to measure and model morphology and spatial patterns of gene expression in animal development.

Dr. Takeo Kanade

U.A. and Helen Whitaker University Professor, RI/CS
The Robotics Institute
Carnegie Mellon University

Topic: Tracking a Large Number of Migrating and Proliferating Cells in Time-Lapse Microscopy Imagery

Takeo Kanade is the U. A. and Helen Whitaker University Professor of Computer Science and Robotics and the director of Quality of Life Technology Engineering Research Center at Carnegie Mellon University. He received his Doctoral degree in Electrical Engineering from Kyoto University, Japan, in 1974. After holding a faculty position in the Department of Information Science, Kyoto University, he joined Carnegie Mellon University in 1980. He was the Director of the Robotics Institute from 1992 to 2001. He also founded the Digital Human Research Center in Tokyo and served as the founding director from 2001 to 2010.

Dr. Kanade works in multiple areas of robotics: computer vision, multi-media, manipulators, autonomous mobile robots, medical robotics and sensors. He has written more than 400 technical papers and reports in these areas, and holds more than 20 patents. He has been the principal investigator of more than a dozen major vision and robotics projects at Carnegie Mellon.

Dr. Kanade has been elected to the National Academy of Engineering and the American Academy of Arts and Sciences. He is a Fellow of the IEEE, a Fellow of the ACM, a Founding Fellow of American Association of Artificial Intelligence (AAAI), and the former and founding editor of International Journal of Computer Vision. Awards he received includes the Franklin Institute Bower Prize, ACM/AAAI Newell Award, Okawa Award, C&C Award, Tateishi Grand Prize, Joseph Engelberger Award, IEEE Robotics and Automation Society Pioneer Award, FIT Accomplishment Award, and IEEE PAMI-TC Azriel Rosenfeld Lifetime Accomplishment Award.

Dr. Erik G. Learned-Miller

Associate Professor, Computer Science
University of Massachusetts Amherst

Topic: Image Alignment, Image Comparison, and Digital Atlases

Erik G. Learned-Miller (previously Erik G. Miller) is an Associate Professor of Computer Science at the University of Massachusetts, Amherst, where he joined the faculty in 2004. He spent two years as a post-doctoral researcher at the University of California, Berkeley, in the Computer Science Division. Learned-Miller received a B.A. in Psychology from Yale University in 1988. In 1989, he co-founded CORITechs, Inc., where he and co-founder Rob Riker developed the second FDA cleared system for image-guided neurosurgery. He worked for Nomos Corporation, Pittsburgh, PA, for two years as the manager of neurosurgical product engineering. He obtained Master of Science (1997) and Ph. D. (2002) degrees from the

Massachusetts Institute of Technology, both in Electrical Engineering and Computer Science. In 2006, he received an NSF CAREER award for his work in computer vision and machine learning.

Dr. Yanxi Liu
Associate Professor
Co-Director: Laboratory for Perception, Action, and Cognition (LPAC)
The Pennsylvania State University

Topic: Capturing Near-regular Patterns in Digitized Life Sciences

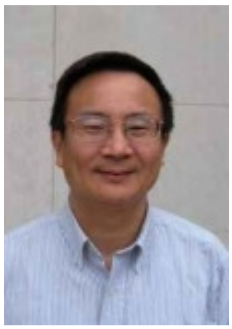
Topic: Discriminative Subspace Learning in Large, Multi-media Biomedical Image Databases - a blessing of dimensionality

Yanxi Liu received her B.S. degree in physics/electrical engineering in Beijing, China, and her Ph.D. degree in computer science for group theory applications in robotics from the University of Massachusetts. Her postdoctoral training was performed in LIFIA/IMAG, Grenoble, France. She has also spent one year at DIMACS (NSF center for Discrete Mathematics and Theoretical Computer Science) with an NSF research-education fellowship award.

Before joining the Departments of Computer Science and Engineering and Electrical Engineering at Penn State in Fall 2006 as a tenured faculty member, Dr. Liu had been with the faculty of the Robotics Institute of Carnegie Mellon University, and affiliated with the Machine Learning Department of CMU. She is also an adjunct associate professor in the Radiology Department of University of Pittsburgh and a guest professor of Huazhong University of Science and Technology in China.

Dr. Liu is the co-director (with Dr. Collins) of the Laboratory for Perception, Action, and Cognition (LPAC) at Penn State. Dr. Liu's research interests span a wide range of applications in computer vision and pattern recognition, computer graphics, medical image analysis and robotics, with two main themes: computational (a)symmetry and discriminative subspace learning. Computational symmetry addresses issues of robust representation, detection, analysis and synthesis of real world (a)symmetries and near-regularities. Discriminative subspace learning focuses on discovering low-dimensional discriminative subspaces from very large (multi-million), multi-modality feature spaces for biomedical image database and computer aided diagnosis applications in particular. With her colleagues, Dr. Liu won first place in the clinical science category and the best paper overall at the Annual Conference of Plastic and Reconstructive Surgeons for the paper "Measurement of Asymmetry in Persons with Facial Paralysis."

Dr. Liu chaired the First International Workshop on Computer Vision for Biomedical Image Applications (CVBIA) in conjunction with ICCV 2005 in Beijing, and co-edited the book: "CVBIA: Current Techniques and Future Trends," Springer-Verlag LNCS 3765. Dr. Liu serves as a reviewer/committee member/panelist for all major journals, conferences, and NIH/NSF panels of computer vision, pattern recognition, biomedical image analysis, and machine learning. She served as a chartered study section member (3-year term) for Biomedical Computing and Health Informatics at NIH. She is a senior member of IEEE and the IEEE Computer Society.



Prof. Hong Ma
Professor
School of Life Sciences
Fudan University

Topic: Chromosome behaviors during Arabidopsis meiosis reveal meiotic recombination mechanisms

Education:
Ph.D., Massachusetts Institute of Technology, 1988
B.A., Temple University, 1983

Postdoc Training:
California Institute of Technology, 1988-1990

Honors and Awards:
Faculty Scholars Medal in Life and Health Sciences, 2005
Guggenheim Fellowship 2004-2005
American Cancer Society Junior Faculty Research Award 1994-1997

Dr. Anant Madabhushi
Associate Professor, Department of Biomedical Engineering
Director, Laboratory for Computational Imaging and Bioinformatics (LCIB)
Rutgers The State University of New Jersey

Topic: Histologic image analysis - unique challenges in digital pathology

Dr. Anant Madabhushi is the Director of the Laboratory for Computational Imaging and Bioinformatics (LCIB) and an Associate Professor in the Department of Biomedical Engineering, Rutgers University. Dr. Madabhushi received his Bachelors Degree in Biomedical Engineering from Mumbai University, India in 1998 and his Masters in Biomedical Engineering from the University of Texas, Austin in 2000. In 2004 he obtained his PhD in Bioengineering from the University of Pennsylvania. He joined the Department of Biomedical Engineering, Rutgers University as an Assistant Professor in 2005. He was promoted to Associate Professor with Tenure in 2010. He is also a member of the Cancer Institute of New Jersey, an Adjunct Associate Professor of Radiology at the Robert Wood Johnson Medical Center, an Adjunct Associate Professor of Radiology at Boston Medical Center, and an Adjunct Associate Professor of Pathology at the University of Pennsylvania. Dr. Madabhushi has authored over 150 peer-reviewed publications in leading international journals and conferences. He has one patent, 15 pending, and 1 provisional patents in the areas of medical image analysis, computer-aided diagnosis, and computer vision. He is an Associate Editor for IEEE Transactions on Biomedical Engineering, IEEE Transactions on Biomedical Engineering Letters, BMC Cancer and Medical Physics. He is also on the Editorial Board of the Journal Analytical and Cellular Pathology. He has been the recipient of a number of awards for both research as well as teaching, including the Busch Biomedical Award (2006), the Technology Commercialization Award (2006), the Coulter Phase 1 and Phase 2

Early Career award (2006, 2008), the Excellence in Teaching Award (2007-2009), the Cancer Institute of New Jersey New Investigator Award (2007, 2009), the Society for Imaging Informatics in Medicine (SIIM) New Investigator award (2008), and the Life Sciences Commercialization Award (2008, 2011). He is also a Wallace H. Coulter Fellow and a Senior IEEE member. His research work has received grant funding from the National Cancer Institute (NIH), New Jersey Commission on Cancer Research, the Society for Imaging Informatics, the Department of Defense, and from Industry. He is also a co-founder of Ibris Inc, a start-up company focused on developing computerized image analysis based technology for breast cancer prognosis.

Dr. B. S. Manjunath
Director, Center for Bio-image Informatics
Vice Chair and Undergraduate Program Director, Dept. of Electrical and Computer Engineering
University of California, Santa Barbara

Topic: Bioimage Informatics, Part 1: Image analysis challenges

Topic: Bioimage Informatics, Part 2: Bisque platform for high-throughput, web-based, bioimage analysis

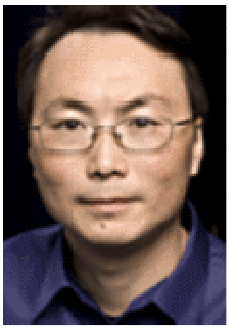
Research Interests: Image/video analysis (including texture and shape analysis, segmentation, registration), multimedia databases and data mining (feature extraction, content based access, high dimensional indexing and similarity search), steganography (data hiding in images and video, and their detection), and signal/image processing for bio-informatics.

Manjunath directs the NSF/ITR funded Bio-Image Informatics Center and was the Principal Investigator for the NSF/IGERT program on Interactive Digital Multimedia. He has published about 250 articles in various journals and peer reviewed conferences and his publications have been cited extensively.

Dr. Tiehua Ni
Research Assistant Professor
Department of Medicine
Vanderbilt University

Topic: Computation Approaches in Integration and Visualization of Developmental heterogeneous data

Dr. Ni's bioinformatics research is centered on large-scale heterogeneous data integration and knowledge discovery. She has received the National Institute of Health Career Development Award in 2005 for developing computational tools and analysis methods for "Cross-platform Large-scale Data Integration and Analysis". She is also directing the project for object-based whole-animal confocal imaging data feature extraction, quantification, and digital phenotyping.



Dr. Hanchuan Peng
Senior Computer Scientist, Janelie Farm Research Campus
Howard Hughes Medical Institute (HHMI)

Topic: Vaa3D: high-performance visualization & analysis for 3D images

Topic: High-throughput analysis of microscopic images using 3D digital atlases of model animals

is currently a senior computer scientist and the head of a computational bioimage analysis lab at Janelia Farm Research Campus, Howard Hughes Medical Institute. He was previously with Lawrence Berkeley National Laboratory, UC Berkeley, on computational biology, bioinformatics, and high-performance data mining, and Johns Hopkins University Medical School on human brain imaging and analysis. Dr. Peng is interested in bioimage analysis and large-scale informatics, as well as computational biology. His recent work has been focusing on developing novel algorithms for 3D+ image analysis and data mining, building single-neuron whole-brain level 3D digital atlases for animals including fruit fly and C. elegans, and V3D, which is a high-performance visualization-assisted analysis system for large 3D+ biological and biomedical- image data sets. He is also the inventor of the minimum-redundant maximum-relevance (mRMR) feature selection algorithm. Dr. Peng is an organizer of some recent international meetings on microscopic image analysis and informatics, e.g. 2005 (Stanford), 2006 (Santa Barbara) and 2009 and 2011 (Janelia Farm) Bioimage Informatics Conferences, 2010 Turning-Images-to-Knowledge Conference (Janelia Farm), 2008 and 2010 Computer Vision for Neurosciences meetings, 2010 Hackathon on 3D Image Visualization and Analysis, etc.

Dr. Zhuowen Tu
Assistant Professor
Depts. of Neurology and Computer Science
University of California, Los Angeles

Topic: Discriminative Models for Medical Imaging

Zhuowen Tu's current research is on exploring structural information within/between data population for computer vision, machine learning, and medical imaging. He is also deveoping theoratical and practical methods along supervised, weakly-supervised, and unsupervised learning.

Zhuowen Tu is currently taking a leave of absence to work at Microsoft Research Asia; he is an assistant professor in the lab of neuro imaging (LONI), and the Department of Computer Science, University of California, Los Angeles. He is also affiliated with the Bioengineering IDP program and Bioinformatics IDP program at UCLA. He received his PhD from the Ohio State University.

Xiaohui Wu, Ph.D.
Professor
Institute of Developmental Biology and Molecular Medicine
Fudan University

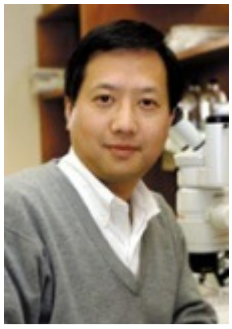
Topic: Phenotypic Analysis of Developmental and Metabolic Defects in Mice

Professor Wu, Xiaohui obtained his B.S. and Ph.D. degrees at Fudan University (FDU) in 1995 and 2001, respectively. He joined Institute of Developmental Biology and Molecular Medicine (IDM), FDU in 2001, where he was promoted to an Associate Professor, Professor, and Distinguished Professor in 2002, 2005, and 2008, respectively. He also serves as a member of the Developmental Genetics Committee of the Genetics Society of China, and the Council of Shanghai Genetics Society.

Prof. Hongbo Yu
Professor
School of Life Science
Fudan University

Topic: Multiple scale functional and structural imaging in vivo

B. A. degree in Biology in 1995 from University of Science and Technology of China (USTC); Ph. D. in Biophysics from USTC in 2000, in a joint program of USTC and Fudan University from 1997 to 2000. Post-doctoral fellow at Picower Institute of Learning and Memory and Department of Brain and Cognitive Sciences in MIT from 2000 to 2009; Professor in the School of Life Sciences, Fudan University, since 2009.



Tao P. Zhong, Ph.D.
Professor
School of Life Sciences
Fudan University

Topic: Pattern formation and morphogenesis in vertebrate embryo and organ development

Dr. Tao Zhong is Full Professor in School of Life Sciences in Fudan University. His research interests focus on signaling and molecular mechanisms regulating embryo development as well as cardiovascular patterning and morphogenesis. Dr. Zhong graduated from Fudan University Shanghai Medical School in Medicinal Chemistry in 1987. He obtained his Ph.D. in Genetics from Cold Spring Harbor Laboratory and State University of New York at Stony Brook in 1995, where he studied yeast cell cycle and protein translation regulation. He then moved to MIT and Harvard Medical School as a postdoctor fellow to study heart and blood vessel development in zebrafish, an ideal vertebrate model that affords a powerful combination of genetic analyses with molecular, chemical and computation approaches. Dr. Zhong obtained his first faculty position in Vanderbilt University School of Medicine in 2002, where he was appointed as Assistant Professor (tenure-track) in Medicine, Pharmacology and Cell & Developmental Biology. He also served as Invited Lecture Professor in Fudan University (2002-2010). Dr. Zhong's group currently investigates development and regeneration of heart and blood vessel using a combination of approaches in genetics, development, chemistry and computation.

Detailed Schedule of Events

Monday, July 23

8:30 – 8:45 am **Opening Talks**

8:45 – 9:30 am Dr. Hanchuan Peng
High-throughput analysis of microscopic images using 3D digital atlases of model animals [1–10]

Case Studies:
- Applications in cell biology, gene expression analysis, neuroscience, etc.
- Methods: 3D segmentation, tracing, registration, visualization, data mining, modeling
- Major challenges and future directions

9:30 – 10:00 am **Tea/Coffee Break, Group Photo**

10:00 – 11:00 am Dr. Hanchuan Peng
High-throughput analysis of microscopic images using 3D digital atlases of model animals (Cont'd) [11–21]

Case studies:
- High resolution C. elegans digital map and single cell analyses
- Zebrafish image segmentation and informatics
- Fruit fly bioimage informatics (segmentation/tracing, registration, annotation, and modeling)
- Others & industrial applications (e.g. electron microscopy image alignment, segmentation and 3D reconstruction, cell segmentation and tracking, etc.)

11:00 – 12:00 noon **Prof. Hongbo Yu**
Multiple scale functional and structural imaging in vivo [22–25]

- None invasive brain functional imaging - fMRI
- Intrinsic optical imaging and voltage-sensitive dye imaging - fast functional screening of the brain
- Two photon calcium imaging - to see what we record physiologically at single cell resolution
- Two photon structural imaging - to monitor the neural network and the dynamics of subcellular structure
- Super-resolution imaging - the approach to image big biological molecues
- Data analysis - common difficulties and current tools

12:00 – 2:00 pm **Lunch**

2:00 – 3:00 pm Prof. Anant Madabhushi
Digital Pathology: Role of Image Analysis (Part I) [26]

- What is Digital Pathology?
- Why is Digital Pathology so different from radiologic images?
- What are the unique questions one can pose with digital pathology?
- Need for unique image computing tools in digital pathology

3:00 – 3:30 pm **Tea/Coffee Break**

3:30 – 4:30 pm Prof. Anant Madabhushi
Computer aided prognosis (Part II) [27], [28]

- What is computer aided prognosis?
- Feature extraction and characterization from digital pathology
- Classification of high dimensional feature spaces
- Use case of Computer aided prognosis in prostate cancer
- Use case in breast cancer

4:30 – 5:30 pm **Review/Discussion**

Evening event **Welcome Dinner**

Tuesday, July 24

8:30 – 9:30 am — Prof. Anant Madabhushi

Histologic image analysis - unique challenges in digital pathology Quantitative data convergence (Part III) [29]

- Introduction to QDC
- Convergence of radiology and histology
- Convergence of radiologic and molecular data
- Convergence of histogic and molecular data
- Cross modality correlations - What can we learn and how?

9:30 – 10:00 am — **Tea/Coffee Break**

10:00 – 11:00 am — Dr. Hanchuan Peng

Vaa3D: Visualization-assisted analysis in 3D [30], [31]

11:00 – 12:00 noon — Prof. Hong Ma

Chromosome behaviors during Arabidopsis meiosis reveal meiotic recombination mechanisms [32], [33]

Meiosis is essential for sexual reproduction in humans, animals, plants and other eukaryotes. Meiotic recombination facilitates the re-distribution of genetic variation and is important for plant and animal breeding. Defects in meiotic recombination can cause infertility and birth defects in humans and much of the understanding of meiosis have been obtained through image analysis. We use the model plant Arabidopsis thaliana to investigate meiotic recombination and the genes that are required for this process. Light and electron microscopy are essential for observing meiotic chromosomes and properties of chromosomes detected in the microscopic images are used to infer mechanisms of meiotic recombination. In particular, aspects of the meiotic chromosomes that show dramatic differences in mutant meiotic cells reveal that the genetic defects are causing abnormal meiotic recombination, thereby uncovering steps in the meiotic recombination that are either unknown or lacking details. Specific examples will be presented to illustrate how images are examined and which aspects are crucial for understanding meiosis. Although analysis of microscopic images can be done by scientists with sufficient training, it is rather laborious and challenging to analyze many hundreds of images within a short time. It is highly desirable to be able to analyze meiotic chromosome images using computational methods, such that normal and defective images can be accurately indicated and the specific defects can be recognized and used to conclude regarding the meiotic abnormalities.

12:00 – 2:00 pm — **Lunch**

2:00 – 3:00 pm — Prof. B. S. Manjunath

Bioimage Informatics, Part 1: Image analysis challenges [34]

A fundamental problem in bioimage analysis--and a major bottleneck in the workflow--is that of spatial-temporal segmentation of the data. In the context of microscopy images, these data include the traditional 2D images, as well as the 3D stack images (consisting of optical section, 4D (time lapse plus 3D) and 5D (4D plus spectral).

a) Overview of the problem and some biological examples drawn from current research

b) Segmentation and tracing in electron micrographs towards building a retinal connectome
c) Introduction to probabilistic graphical models in image analysis, Markov Random Fields and interactive segmentation

3:00 – 3:30 pm **Tea/Coffee Break**

3:30 – 4:30 pm Prof. B. S. Manjunath
Bioimage Informatics, Part 1: Image analysis challenges (Cont'd) [35], [36]

d) 3D tracing of multiple structures in EM data and issues of scalability
e) Super-pixel based multiple segmentations and fusion
f) Tracking examples (microtubule and melansome tracking), challenges; Simultaneous detection and tracking framework, scalability and robustness issues in tracking

4:30 – 5:30 pm **Review/Discussion**

Wednesday, July 25

8:30 – 9:30 am — Prof. B. S. Manjuanth

Bioimage Informatics, Part 2: Bisque platform for high-throughput, web-based, bioimage analysis [37], [38]

Bisque is a web-based image database system for storing, managing, analyzing and sharing bioimages. This is an open source software infrastructure that integrates image analysis with databases, and supports most existing microscopy image formats, and including 2D, 3D, 4D and 5D images. In addition to basic functionalities such as viewing, enhancement, and basic analysis modules, users can build and integrate their own modules into Bisque. More information can be found at http://www.bioimage.ucsb.edu.

a) Introduction to BISQUE
b) Loading, annotating, sharing, processing and publishing images in Bisque

9:30 – 10:00 am — **Tea/Coffee Break**

10:00 – 11:00 am — Prof. B.S. Manjuanth

Bioimage Informatics, Part 2: Bisque platform for high-throughput, web-based, bioimage analysis (Cont'd) [37], [38]

c) Graphical annotations and tagging
d) Image analysis workflow and case studies on nuclei detection, root tip tracking.

11:00 – 12:00 noon — Dr. Tiehua Ni

Computation Approaches in Integration and Visualization of Developmental heterogeneous data [39], [40]

Identification and characterization of phenotypical changes are important aspects of biological and clinical research to understand underlined gene functions, disease mechanisms, and drug responses. While the advances in imaging technology and experimental systems have largely facilitated the phenotype analysis, there are still unmet needs for systematic phenotype predictions that do not require priori domain expertise and that are easily scalable. Computational approaches for analyzing developmental "omics" data integrated with evidence-based spatial knowledge will be discussed. Specific examples will be presented to demonstrate the utility of these integrated cross-platform data analysis for detecting previously unobserved developmental patterning, defects and the associated molecular signatures. Potential computational strategies for prediction of complex phenotypes will be also discussed.

12:00 – 2:00 pm — **Lunch**

2:00 – 3:00 pm — Prof. Serge Belongie

Visual Recognition With Humans in the Loop [41–44]

- Overview of Visipedia
- Subordinate vs. Basic Level Categorization
- Human Computation Overview
- The Parts and Attributes Framework
- Decision Trees for Interactive Classification
- Dealing with Noise in User Responses

3:00 – 3:30 pm **Tea/Coffee Break**

3:30 – 4:30 pm Prof. Serge Belongie
Crowdsourcing and Its Applications in Computer Vision [44–47]

- Introduction to Mechanical Turk
- Task Incentives
- Experimental Design
- Quality Management
- Cost Effective Strategies for Obtaining Labels
- Example Applications

4:30 – 5:30 pm **Review/Discussion**

Thursday, July 26

Full-day Outing: Suzhou Day Trip

The tour will include the following stops

Zhuozheng Garden (http://www.szzzy.cn/)

Lion Grove Garden (http://en.wikipedia.org/wiki/Lion_Grove_Garden) ,

Hanshan Temple (http://www.travelchinaguide.com/attraction/jiangsu/suzhou/hanshan_temple.htm),

Friday, July 27

8:30 – 9:30 am Prof. Erik Learned-Miller

Image Alignment, Image Comparison, and Digital Atlases, Part I

Introduction to image alignment [48]

- Problem definition
    - Choosing a representation
    - Choosing an alignment criterion
    - Optimizing the alignment criterion
- Some simple representations and alignment criteria
- Optimization methods
    - Exhaustive search
    - Keypoint methods
    - Gradient descent

Multimodal alignment [49]

- Non-parametric density estimation
- Alignment by maximization of mutual information

9:30 – 10:00 am **Tea/Coffee Break**

10:00 – 11:00 am Prof. Erik Learned-Miller

Image Alignment, Image Comparison, and Digital Atlases, Part II

Multi-image alignment [50]

- Problem definition
- A joint alignment criterion
- The congealing algorithm
- Congealing 3D brain volumes [51]
- Digital brain atlases

11:00 – 12:00 noon Prof. Xiaohui Wu

Phenotypic Analysis of Developmental and Metabolic Defects in Mice [52], [53]

Systematic screening for mutants with certain phenotypic alterations is one of the most powerful genetic approaches to study unknown biological processes. This approach allows unbiased identification of important regulatory elements without knowing underlying molecular machinery. It has been widely used in lower organisms during the past century, and made significant contribution to our understanding of the biology. Recently, we and other groups have generated a large number of mutant mice, so that systematic screens would be performed in this popular mammalian model. Mutants with various developmental or disease phenotypes have been successfully identified. In a pilot obesity/diabetes screen, we have isolated dozens of single gene mutations, suggesting these quantitative traits could be controlled qualitatively. Comparing with other model animals, longer generation time and smaller litter size make mice less efficient for genetic screens. Thus, techniques allow high resolution and noninvasive recognition of the structural, morphological, and behavioral changes in a small number of animals are highly desirable for the future study.

12:00 – 1:30 pm **Lunch**

1:30 – 2:00 pm Olympus Corporation (Sponsor)

Deconvolution and Quantitative Imaging Analysis of Fluorescent Image

2:00 – 3:00 pm Prof. Erik Learned-Miller
Image Alignment, Image Comparison, and Digital Atlases, Part III

- Using the warp as an information source
    - Learning from one example [54]
    - Learning about anatomy from joint alignment
- Broadening the notion of alignment
    - Removing multiplicative offsets in MRI
    - Removing slowly varying bias fields in MRI [55]
- Congealing complex images [56]
    - Deep belief nets for congealing

3:00 – 3:30 pm **Tea/Coffee Break**

3:30 – 4:30 pm Prof. Erik Learned-Miller
Image Alignment, Image Comparison, and Digital Atlases, Part IV

- Distribution fields for alignment
    - The basin of attraction issue for gradient algorithms
    - Traditional methods for increasing basin of attraction
    - Distribution fields [57]
    - Applications of distribution fields
        - Tracking [58]
        - Backgrounding
- Summary

4:30 – 5:30 pm **Discussion**

Evening event **Talent Show**

Saturday, July 28

8:30 – 9:30 am Prof. Charless Fowlkes
Automating Biological Image and Shape Analysis

- Core tasks of bioimage analysis: detection, segmentation and tracking
- Capturing contextual interactions and prior knowledge
- End-to-end training and structured prediction

9:30 – 10:00 am **Tea/Coffee Break**

10:00 – 11:00 am Prof. Charless Fowlkes
Automating Biological Image and Shape Analysis (Cont'd) [59–69]

- Mathematical approaches to modeling shape
- Biologically meaningful correspondence
- Connecting form and function
    - Pattern formation in Drosophila development
    - Ear morphology and echolocation in bats

11:00 – 12:00 noon Prof. Tao P. Zhong
Pattern formation and morphogenesis in vertebrate embryo and organ development [70], [71]

Understanding on the patterning and morphogenesis of embryo and organ development has become a subject of enormous scientific and clinical interest. Zebrafish, which have small, accessible, transparent embryos and larvae, provides a unique living animal model to facilitating high-resolution imaging on embryos and developing organ. Numerous transgenic zebrafish lines have been generated with endogenous fluorescent labeling of developing heart. These animals facilitate high-resolution imaging of individual cardiac cell in vivo and make possible long-term time-lapse imaging of the dynamics of cardiac patterning and morphogenesis. We quantify cardiac cell number using confocal microscopy analysis in Tg(cmlc2:EGFP-nuc) embryos in which a gene encoding fluorescent protein is expressed in nuclei under the control of the cmlc2 promoter. These features make zebrafish particularly well suited for discovering small-molecule regulators of cardiac cell production and regeneration. However, computation algorithms are required to develop to facilitate the automation of cardiac cell number quantification. This may ultimately aid in design of therapeutic approaches for heart regeneration and repair.

Brainbow, a new imaging technology, was recently developed that allowed the designation of 90 colour labels to zebrafish developing heart. With this technology, it was possible to visualize adjacent cardiomyocyte and their connections in the heart with high resolution. The ability to assign many colours to different cardiomyocyte in a population can be applied to investigating cardiomyocyte proliferation, lineage decisions, cardiac patterning and morphogenensis. The large amounts of 3-dimensional imaging data are recognized and analyzed by advanced computation methods.

12:00 – 1:30 pm **Lunch**

1:30 – 2:00 pm Beckman Company (Sponsor)

2:00 – 3:00 pm Prof. Yanxi Liu

Capturing Near-regular Patterns in Digitized Life Sciences, Part I: Motivation and Theory [72–76]

- A brief introduction to Pattern Theory and practice
- Symmetry group-based regularity space – a novel, computable model
- Demonstrations of Typical patterns in digitized life science data sets: universal, low-rank, deformed regular patterns
- Computational challenges: why is it hard for computer vision algorithms to discover real world, free-form symmetries?

3:00 – 3:30 pm **Tea/Coffee Break**

3:30 – 4:30 pm Prof. Yanxi Liu

Capturing Near-regular Patterns in Digitized Life Sciences, Part II Tools and Applications [77–96]

Tools:

- discriminative feature subset selection (off-line, on-line) [89], [90], [95]
- curved glide reflection symmetry detection [77], [78]
- skewed rotation symmetry detection [79]
- texture regularity discovery (translation symmetry) [80–82]

Applications:

- 2d/3D human identification, expression/gender classification [83], [84]
- Quantified patterns (firing fields of grid cells) [85], [86]
- Tracking patterns (gated cardiac MRI) [87], [88]
- Evaluation of Scoliosis [77]
- Computer aided diagnosis for neurodegenerative diseases (Alzheimer's Disease, Schizophrenia …) [89], [90]
- Brain tumor detection and segmentation [91]
- Zebra fish (wild versus mutant) [92], [93]
- Human gaits/dance [82], [94]

4:30 – 5:30 pm **Discussion**

Sunday, July 29

8:00 – 9:00 am

Prof. Yan Qiu Chen

Multi-view 3D tracking of particle systems and deforming surfaces, and its application to biomedical research [97–105]

This lecture starts with sampling natural phenomena such as bird flocks, insect swarms, fish schools, smiling human faces, waving flags etc. that give rise to the abstract notion of dynamic particle system and deforming surface. It will then discuss the scientific values and potential applications of studying such natural phenomena, and will explain why 3D tracking is key to quantitative investigation into them that may help discover the underlying rules and models governing their motion.

By discussing a selected collection of existing methods for multi-view 3D tracking particle system and deforming surface, the lecture tries to assist the audience in appreciating the challenges facing the task of measuring 3D complex motion, and in building up a repertoire of useful techniques and in mastering their advantages and pinpointing their shortcomings.

In summary, the major aim of the lecture is to help consolidating the audience's quest for knowledge of the fascinating complex motion patterns in Nature, and to assist the audience in acquainting themselves with the very useful state-of-the-art computer vision technology.

9:00 – 9:45 am

Prof. Margrit Betke

Seeing in the Dark - Unveiling the Flight Behavior of Gregarious Bats Using Thermal Imaging [101], [106–108]

Colonies of bats represent some of the largest aggregations of mammals known to humankind. Censusing is important for understanding the ecological and economic impact of these gregarious animals. We have developed video analysis techniques for detecting, tracking, and counting bats as they emerge in dense formations from their caves. Since bats fly at night, we used multiple thermal infrared cameras to record and stereoscopically reconstruct their flight paths. Tracking large numbers of bats in multiple views is challenging because data association must be performed not only across time, as in single-camera tracking, but also across camera views; this is a multidimensional assignment problem, which is NP-hard. We present several techniques for occlusion reasoning, 3D tracking, and analysis of group behavior.

9:45 – 10:00 am

Tea/Coffee Break

10:00 – 11:00 am

Prof. Takeo Kanade

Tracking a Large Number of Migrating and Proliferating Cells in Time-Lapse Microscopy Imagery [109–111]

We have been developing a computer-vision based system that precisely and individually tracks a large number of living cells in a phase-sensitive (phase-contrast and DIC) microscopy image sequence, and detects cell events, such as migration (translocation), mitosis (division), apoptosis (death), and differentiation. The output is a complete cell lineage of the whole cell population, together with description and statistics of cells' shape, appearance, and motion. We are trying to make such technologies publically available through the Internet, hoping that such a capability of high-throughput spatiotemporal analysis helps biologists and tissue engineers to

understand and direct cell growth. The talk will present the techniques, the system, and applications that we have worked on to date.

11:00 – 12:00 noon Prof. Robert Collins
Video Tracking and Crowd Scene Analysis, Part 1: Tracking Foundations

- Appearance-based vs. tracking-by-detection
- Single target tracking
    - Recursive filtering [101], [112]
    - Dynamic programming [113]
- Multiple target tracking [60], [114], [115]
    - Filtering and data association
    - Multi-frame formulations

12:00 – 1:30 pm **Lunch**

1:30 – 2:30 pm Prof. Robert Collins
Video Tracking and Crowd Scene Analysis, Part 2: Analyzing Crowd Behavior

- Detection and counting [116], [117]
- Crowd flow analysis [118–120]
- Social force models [121], [122]
- Detecting small groups [123]

2:30 – 3:30 pm Prof. Zhuowen Tu
Discriminative Models for Medical Imaging

One direction in medical image analysis is to effectively represent knowledge and efficiently extract biomedical information (such as a deformable shape) from medical images. In particular, machine learning techniques (supervised, weakly-supervised, and unsupervised) have played increasingly important role. The large-scale data learning and analysis have also recently played a significant role in medical imaging.

The goal of this lecture is to provide a comprehensive assessment of discriminative learning techniques used for medical imaging applications such as anatomical structure detection and segmentation, image categorization, etc. Learning from an annotated dataset the covers the uncertainties involved in the applications, these techniques are able to derive compact descriptions between the image and knowledge and gain improvements in performance and speed when compared with conventional algorithms without using learning.

Coverage: Basics about supervised and semi-supervised learning

3:30 – 3:45 pm **Tea/Coffee Break**

3:45 – 4:45 pm Prof. Zhuowen Tu
Discriminative Models for Medical Imaging (Cont'd)

Coverage: Applications of supervised and semi-supervised learning in recent medical imaging applications.

4:45 – 5:45 pm **Closing Ceremony**

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