



**THE CHINESE UNIVERSITY OF HONG KONG**

*Joint seminar of  
Department of Electronic Engineering and  
Department of Information Engineering*

**Biomedical Image Analysis, Indexing and Retrieval ---  
An Exploration in the Discriminative Subspaces**

by

**Professor Yanxi Liu**

**Computer Science Engineering and Electrical Engineering Departments  
Penn State University**

**Date : 9 February, 2010 (Tue.)  
Time : 10:30am-11:30am  
Venue : Room 833, Ho Sin Hang Engineering Building  
The Chinese University of Hong Kong**

*Abstract*

With the rapid development in computer industry, our whole society faces the challenge of “... drowning in information and starving for knowledge” (Rutherford D. Roger). How to efficiently extract the most discriminative information from data of very high dimensions becomes the bottleneck of many applications of information technology. This phenomenon becomes particularly evident in terabytes of digital biomedical images and collateral information. The goal of our current research is focusing on learning relevant biomedical image features for discrimination. I shall describe our work in 3D pathological neural image indexing and retrieval, where image alignment and brain asymmetry play an important role for extracting semantically meaningful image features; our results on cancer cell detection using hyperspectral microscopic images starting with 10,000 potential image features; and our recent exploration in high resolution MR structural images for early diagnosis of neural degenerative diseases (Alzheimer’s disease, Schizophrenia and Autism) with initial feature set over several millions. In all applications, we develop an effective set of algorithms under a multivariate statistical learning framework in searching for and validating the smallest, most discriminative image feature subspaces. Additional applications using this general framework includes gender, expression and identity discrimination from 3D face data, age and gender discrimination from brain images, and gender discrimination from motion capture data sets (gait, sports, dance) as well as a widely cited work of ours on [Online selection of discriminative tracking features](#).

*Biography*

Yanxi Liu received her B.S. degree in physics/electrical engineering in Beijing and her Ph.D. degree in computer science for group theory applications in robotics from University of Massachusetts (Amherst). Her postdoctoral training was at LIFIA/IMAG (France). She also spent one year at DIMACS (NSF center for Discrete Mathematics and Theoretical Computer Science) under an NSF research-education fellowship award. Dr. Liu was with the research faculty in the Robotics Institute (RI) of Carnegie Mellon University before she joined the Computer Science Engineering and Electrical Engineering departments of Penn State University in Fall of 2006 as a tenured faculty and the co-director of the lab for perception, action and cognition (LPAC). Dr. Liu's research interests span a wide range of applications including computer vision, computer graphics, robotics, human perception and computer aided diagnosis in medicine, with two main themes: computational symmetry/regularity and discriminative subspace learning. Dr. Liu chaired the First International Workshop on Computer Vision for Biomedical Image Applications (CVBIA) in conjunction with ICCV 2005. Dr. Liu served as an area chair or organizing committee member for CVPR08/MICCAI08/CVPR09, and has served as a multi-year chartered study section member for the US National Institute of Health (NIH). Dr. Liu is a senior member of IEEE and the IEEE Computer Society.

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## Computational Symmetry

by

**Professor Yanxi Liu**

**Computer Science Engineering and Electrical Engineering Departments  
Penn State University**

**Date : 9 February, 2010 (Tue.)  
Time : 2:30pm-3:30pm  
Venue : Room 833, Ho Sin Hang Engineering Building  
The Chinese University of Hong Kong**

### Abstract

Symmetry is an essential mathematical concept, as well as a ubiquitous, observable phenomenon in nature, science and art. Either by evolution or by design, symmetry implies an efficiency coding that makes it universally appealing, especially so to computational science. Recognition and categorization of symmetry and regularity is the first step towards capturing the essential skeleton of a real world problem, while at the same time minimizing computational redundancy. However, symmetry group detection from real world data turns out to be a challenging problem that has been puzzling computer vision, computer graphics and psychology researchers for decades. We explore a formal and computational characterization of real world regularity using a hierarchical model of symmetry groups as a theoretical basis, embedded in a well-defined Bayesian framework. Such a formalization simultaneously facilitates (1) a robust and comprehensive algorithmic treatment of the whole regularity spectrum, from regular (perfect symmetry), near-regular (approximate symmetry), to various types of irregularities; (2) an effective detection scheme for real world symmetries and symmetry groups; and (3) a set of computational bases for measuring and discriminating quantified regularities on diverse data sets.

Besides some theoretical background on crystallographic groups in particular, we shall illustrate various applications of computational symmetry in texture synthesis, analysis, tracking, and manipulation; human gait and activity recognition; symmetry-based dance analysis; grid-cell clustering; automatic geotagging; and image 'de-fencing'.

### Biography

Yanxi Liu received her B.S. degree in physics/electrical engineering in Beijing and her Ph.D. degree in computer science for group theory applications in robotics from University of Massachusetts Amherst). Her postdoctoral training was at LIFIA/IMAG (France). She also spent one year at DIMACS (NSF center for Discrete Mathematics and Theoretical Computer Science) under an NSF research-education fellowship award. Dr. Liu was with the research faculty in the Robotics Institute (RI) of Carnegie Mellon University before she joined the Computer Science Engineering and Electrical Engineering departments of Penn State University in Fall of 2006 as a tenured faculty and the co-director of the lab for perception, action and cognition (LPAC). Dr. Liu's research interests span a wide range of applications including computer vision, computer graphics, robotics, human perception and computer aided diagnosis in medicine, with two main themes: computational symmetry/regularity and discriminative subspace learning. Dr. Liu chaired the First International Workshop on Computer Vision for Biomedical Image Applications (CVBIA) in conjunction with ICCV 2005. Dr. Liu served as an area chair or organizing committee member for CVPR08/MICCAI08/CVPR09, and has served as a multi-year chartered study section member for the US National Institute of Health (NIH). Dr. Liu is a senior member of IEEE and the IEEE Computer Society.

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