IWCIA 2008
12th International Workshop on Combinatorial Image Analysis
Adam's Mark Hotel, Buffalo, NY, USA
April 7-9, 2008

Invited Speakers

Opening Talk
Monday, April 7, 9:10-10:10 AM
Fountain Room

Herbert A. Hauptman, *Nobel Laureate*
Professor, President of the Hauptman-Woodward Medical Research Institute
Buffalo, NY

Biosketch: Dr. Hauptman received a bachelor's degree in mathematics from the City College of New York in 1937 and a master's degree in mathematics from Columbia University in 1939. After participating in World War II, he received his doctoral degree from the University of Maryland in 1955.

After the war, Dr. Hauptman moved to Washington, D.C. to work in the Naval Research Laboratory. There, in collaboration with Jerome Karle, a physical chemist, he studies the phase problem of X-ray crystallography (a technique in crystallography in which the pattern produced by the diffraction of X-rays through the closely spaced lattice of atoms in a crystal is recorded and then analyzed to reveal the nature of that lattice). Hauptman and Karle devised mathematical equations to extract phase information from the intensity of spots resulting from the diffraction of X-rays deflected off crystals. Their equations made it possible to determine invisible structures of crystal's molecules, based upon an analysis of the intensity of the spots. This, in turn, allows determining the three-dimensional structure of thousands of small biological molecules, including those of many hormones, vitamins, and antibiotics.

In 1970, Dr. Hauptman moved to join the crystallography team at the Medical Foundation of Buffalo. He became a professor of biophysics at the State University of New York at Buffalo. In 1972, he was elected Research Director of the institution. During this period, that Dr. Hauptman devised the neighborhood principle and extension concept. In the 80s he initiated work on the problem of combining the traditional techniques of direct methods with isomorphous replacement and anomalous dispersion in the attempt to facilitate the solution of macromolecular crystal structures. This work continues to the present time. More recently he has formulated the phase problem of X-ray crystallography as a minimal principle in the attempt to strengthen the existing direct methods techniques. Dr. Hauptman received the Nobel Prize for Chemistry in 1985 along with Jerome Karle for their work with X-ray crystallography.

(From his autobiography and the biographies at Hauptman-Woodward Medical Research Institute and Encyclopaedia Britannica; The picture is from www.hwi.buffalo.edu/Faculty/Hauptman/Hauptman.html)

Representation and Modeling of Spatial Patterns of Dynamics in Images

Tuesday, April 8, 8:40-9:40 AM
Wright Room

Polina Golland
Professor
Computer Science and Artificial Intelligence Laboratory (CSAIL)
Massachusetts Institute of Technology

Biosketch: Professor Golland received BSc and Masters in Computer Science from Technion, Israel and a PhD in Electrical Engineering and Computer Science from MIT. She works on developing novel techniques for image analysis and understanding. She designs algorithms that either explore the geometry of the world and the imaging process in a new way or improve image-based inference through statistical modeling of the image data. Prof. Golland is interested in shape modeling and representation, predictive modeling and visualization of statistical models. Her current research focuses on developing statistical analysis methods for characterization of biological processes using images (from MRI to microscopy) as a source of information.

Prof. Golland is an Associate Editor of the IEEE Transactions on Medical Imaging's Special Issue on Mathematical Modeling in Biomedical Image Analysis. She has chaired MMBIA 2006: IEEE Computer Society Workshop on Mathematical Methods in Biomedical Image Analysis, and has been Area Chair or Program Committee Member of a number of other conferences. Prof. Golland is a recipient of various academic awards, among which NSF CAREER Award, the Stanley Foundation Fellowship and the Intel Graduate Fellowship.

Abstract

In this talk, I will present a novel approach to computational modeling of spatial activation patterns observed through fMRI. The traditional way to define networks considers correlation with a user-selected `seed' region of interest. In contrast, our method simultaneously identifies interesting seed time courses and associates voxels with the respective networks. Based on the empirical observation that the detected patterns of co-activation are inherently hierarchical, we propose a new representation for spatial patterns of functional organization. Just like the anatomical hierarchies represent the structure of the brain as a tree of increasingly simple systems, we believe that the functional description of the brain should also be of a hierarchical nature. We construct the functional hierarchy through an iterative decomposition that utilizes clustering for network subdivision at each step. The experimental results demonstrate that the functional region hierarchy provides a robust and anatomically meaningful model for spatial patterns of co-activation in fMRI. In addition, subject-specific region hierarchies tend to share common tree structure, further confirming the validity of this representation for modeling group-wise patterns of co-activation.

Computer Recognition of Human Activities, Objects and their Interactions

Tuesday, April 8, 1:40-2:40 PM
Wright Room

Jake K. Aggarwal
Distinguished Professor
Computer & Vision Research Center
The University of Texas at Austin

Biosketch: Professor Aggarwal earned his B.Sc. from University of Bombay, India, B. Eng. from University of Liverpool, UK, and M.S. and Ph.D. from University of Illinois, Urbana, Illinois.

He has made seminal contributions in diverse research areas including digital signal processing, image processing, pattern recognition, and computer vision. His current research focuses on understanding of human motion and interactions using computer vision and content-based image/video retrieval. One of the goals of his present research is to build a bridge between human motion understanding and content-based video retrieval and summarization for the automatic analysis and understanding of video.

In ground-breaking work on object recognition, Prof. Aggarwal developed an algorithm to determine the edges of curved or planar 3D objects leading to the identification of object boundaries, which received the Pattern Recognition Society's Best Paper Award. The segmentation and analysis of the scene based on curvature of object boundaries enabled recognition of objects from partial views. This algorithm has since been employed in the recognition of industrial parts.

Prof. Aggarwal has served as the Director of Computer and Vision Research Center at the University of Texas at Austin since 1985. He has graduated 38 Ph.D. and 53 Masters students. He has edited/co-edited and authored/co-authored seven books, and has published over 175 refereed archival journal articles, as well as 200+ refereed conference papers. Professor Aggarwal is a recipient of numerous prizes; among them the 2004 K. S. Fu Prize of the IAPR and the 2005 Leon K. Kirchmayer Graduate Teaching Award of the IEEE. He has served as the Chairman of the IEEE Computer Society Technical Committee on Pattern Analysis and Machine Intelligence (1987-1989), Director of the NATO Advanced Research Workshop on Multisensor Fusion for Computer Vision, Grenoble, France (1989), Chairman of the IEEE Computer Society Conference on Computer Vision and Pattern Recognition (1993), and the President of the International Association for Pattern Recognition (1992-1994). He is a life fellow of IEEE and Golden Core Member of IEEE Computer Society.

Abstract

Computer Vision has graduated from a research tool in early 1960s to a mature discipline today. The developments in cameras, computers and memory have contributed in part to this maturing of computer vision. Namely, there is an explosive growth in the number of cameras in public places, the speed of computers has increased significantly and the price of memory has spectacularly decreased. The word camera may be used in a very broad sense since the imaging modalities range from the usual cameras imaging a visual intensity image to thermal image and laser range image. Further, the developments in computer vision are poised to contribute to the solution of a diverse set of societal problems.

At The University of Texas at Austin, we are pursuing a number of projects on human motion understanding. Professor Aggarwal will present his research on modeling and recognition of human faces, actions and interactions, and human and object interactions. The object may be a piece of luggage, a car or an unmovable object like a fence. The applications considered include monitoring of: human activities in public places, abandoned baggage, parking of cars on roads and in parking lots, breaking into cars and estimating vehicular traffic on highways. The issues considered in these problems will illustrate the richness of ideas involved and the difficulties associated with understanding human activities. Application of the above research to monitoring and surveillance will be discussed together with actual examples and their solutions.

Virtual Colonoscopy with Computer-Aided Polyp Detection

Wednesday, April 9, 8:40-9:40 AM
Wright Room

Arie E. Kaufman
Distinguished Professor & Chair, Computer Science Department
Director, Center for Visual Computing
Stony Brook University

Biosketch: Professor Kaufman received a BS in Mathematics and Physics from the Hebrew University of Jerusalem, Israel, an MS in Computer Science from the Weizmann Institute of Science, Rehovot, Israel, and a PhD in Computer Science from the Ben-Gurion University, Israel. He is internationally recognized for his contributions to visualization, graphics, virtual reality, user interfaces, multimedia, and their applications, especially in biomedicine. He is a pioneer in the area of volume graphics. He has developed the Cube hardware architecture of real time volume rendering and 3D virtual colonoscopy.

Prof. Kaufman has published extensively totaling in excess of 260 refereed papers, books, and book chapters, more than 220 conference presentations and non-refereed manuscripts, and has been awarded/filed more than 30 patents, most of which have been licensed. He has been a principal/co-principal investigator on more than 90 research grants. His work has been featured in numerous media communications, including Science, New York Times, U.S. News & World Report, Business Week, Wall Street Journal, Saturday Evening Post, PC Week, Good Morning America, Fox TV and Newsday.

Prof. Kaufman was elected to the highest level of a Fellow of IEEE "for contributions to and leadership in visualization and computer graphics" and received the prestigious IEEE Visualization Career Award “for seminal work in the theory and practice of volume visualization." Kaufman also received the 1995 IEEE Outstanding Contribution Award, 1998 ACM Service Award, 1999 IEEE Computer Society's Meritorious Service Award, 2002 State of New York Entrepreneur Award, 2004 IEEE Harold Wheeler Award, and 2005 State of New York Innovative Research Award. He is a member of the European Academy of Sciences.

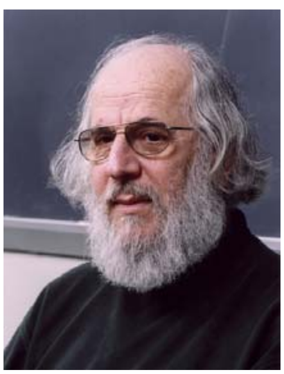
Abstract

A combination of computed tomography (CT) scanning and volume visualization technology, called virtual colonoscopy (VC), is rapidly gaining popularity. VC is poised to become the procedure of choice in lieu of the conventional optical colonoscopy for

mass screening for colon polyps – the precursor of colorectal cancer. The patient abdomen is imaged by a helical CT scanner during a 40-second single-breath-hold. A 3D model of the colon is then reconstructed from the CT scan by automatically segmenting the colon out of the rest of the abdomen and employing an "electronic cleansing" algorithm for computer-based removal of the residual material. The visualization software allows the physician to interactively navigate through the colon using volume rendering. An intuitive user interface with customized tools supports 3D measurements, "virtual biopsy" to inspect suspicious regions and "painting" to help in visualizing 100% of the colon surface. Unlike conventional optical colonoscopy, VC is patient friendly, fast, non-invasive, more accurate, cost-effective procedure for mass screening of colon polyps. Our VC further incorporates a novel pipeline of computer-aided detection (CAD) of colonic polyps. Our CAD pipeline automatically detects polyps by integrating volume rendering, conformal colon flattening, and clustering, with texture and shape analysis.

Combinatorial Classification of Heterogeneous Electron Microscopic Projection Images into Homogeneous Subsets

(in collaboration with M. Kalinowski)
Wednesday, April 9, 1:40-2:40 PM
Wright Room



Gabor T. Herman
Distinguished Professor
Graduate Center, The City University of New York

Biosketch: Professor Herman received a B.S. and M.S. in Mathematics from the University of London, an M.S. in Electrical Engineering from the University of California at Berkeley, and Ph.D. in mathematics from the University of London. He is a pioneer in the field of computerized tomography (an important medical diagnostic procedure) and the author of several books and well over one hundred articles including several classic works in their fields. Prof. Herman is recognized internationally for his major contributions to image processing and its medical applications. He was the leader of successful medical image-processing groups at SUNY Buffalo and at the University of Pennsylvania and has garnered multiple millions of dollars in research funding. His currents interests include image processing in biological 3D electron microscopy and in X-ray crystallography of materials, as well as various aspects of discrete tomography.

Prof. Herman is a highly accomplished scientist of international distinction and has been awarded honorary degrees from the universities of Haifa in Israel, Szeged in Hungary, and Linkoping in Sweden. Prior to coming to The Graduate Center, he was Hewlett Packard Visiting Research Professor at the Mathematical Sciences Research Institute at the University of California-Berkeley.

Abstract
Three-dimensional electron microscopy (3D-EM) is a powerful tool for visualizing complex macromolecules. In the so-called single particle reconstruction problem we assume that we have multiple identical copies of the same macromolecule and the task is the reconstruction of the common structure. It is often the case, however, that the macromolecule to be reconstructed has multiple not-exactly identical conformations and

so the set of projection images from which we need to reconstruct is a heterogeneous mixture of projections of more than one conformation. For high resolution 3D-EM, the effect of this is quite dramatic and severely limits the achievable resolution. In this talk a combinatorial method is described for partitioning such heterogeneous projection data sets into homogeneous components, each of which consists of projections of mostly one conformation. The method operates directly on the 2D projection images, and it does not require reference images or the performance of 3D reconstructions. It is demonstrated that the approach can be successfully applied to noisy data.