KAR-HAN TAN

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Education

University of Illinois at Urbana-Champaign
Ph.D. in Computer Science, 2003.
Advisor and Thesis Chair: Narendra Ahuja
Thesis Committee: David J. Kriegman, Michael Garland, and Yizhou Yu
Thesis title: "Visual Objects and Environments: Capture, Extraction, and Representation"

University of California at Los Angeles
M.S. in Computer Science, 1996.
Co-Advisors: M. Anthony Lewis and Andrew B. Kahng

National University of Singapore
B.Sc. in Computer Science, 1994.

Awards and Honors

Beckman Institute Graduate Fellowship. 1999 - 2000.
Dean's list. Department of Computer Science, National University of Singapore. 1994.

Research, Teaching, and Technical Experience

Senior MTS - Research Scientist. Epson R & D, Palo Alto, CA. Winter 2004 -
Research Scientist. Vision Technology, Champaign, IL. Spring - Fall 2004.
Postdoc Visiting Scientist. Mitsubishi Electric Research Labs, Cambridge, MA. Fall 2003.
Visiting Research Scientist. Vision Technology, Champaign, IL. Summers 2002, 2003.
Visiting Research Scientist. Sarnoff Corporation, Princeton, NJ. Summer 1998.
Teaching Assistant. ECE370 Introduction to Robotics. Fall 1998.
Research Assistant. UIUC Beckman Institute Computer Vision and Robotics Lab, 1997-2002.
Research Assistant. UCLA Cooperative Mobile Robotics Laboratory. 1996.

Professional Activities

Program committee, IEEE Workshop on Projector-Camera Systems 2006.
Reviewer for ACM SIGGRAPH, IEEE ICCV, CVPR, ICPR, OSA Optics Express.

Extracurricular Activities

Elected to the executive committee, Singapore Students Association, University of Illinois.
Elected to the executive committee, National University of Singapore Concert Orchestra.
Appointed Section Commander during military service with the Singapore Armed Forces.

Patents

1. K.-H. Tan and A. K. Bhattacharjya. Surround Video. US Patent Application filed 2005.
2. K.-H. Tan, K. Bhat, J. Zhang, and A. K. Bhattacharjya. Surround Video. US Provisional Patent Application filed 2005.
3. K.-H. Tan, J. Xiao, and A. K. Bhattacharjya. The View Projection Matrix. US Provisional Patent Application filed 2005.

Journal Publications

1. K.-H. Tan, H. Hua, and N. Ahuja. Multiview Panoramic Cameras with a Mirror Pyramid. **IEEE Transactions on Pattern Analysis and Machine Intelligence**. 26(7):941-946, July 2004.
2. R. Raskar, K.-H. Tan, R. S. Feris, J. Yu, M. Turk. Non-photorealistic Camera: Automatic Stylization with Multi-Flash Imaging. In Proceedings **SIGGRAPH** 2004, and **ACM Transactions on Graphics** 23(3) July 2004.
3. A. Ray Chaudhuri, A. Basu, K.-H. Tan, S. Bhandari, and B. B. Chaudhuri. An Efficient Approach to Consistent Set Estimation in Finite Dimensions. **Computer Vision and Image Understanding** 93(3):260-287, March 2004.
4. M. A. Lewis and K.-H. Tan. High Precision Formation Control of Mobile Robots Using Virtual Structures. **Autonomous Robots** 4, 387-403. 1997.
5. H. Park, C.B. Park, C. Tzoganakis, K. Tan, and P. Chen. Surface Tension Measurement of Polystyrene Melts in Supercritical Carbon Dioxide. **Industrial and Engineering Chemistry Research**. American Chemical Society Publications. Accepted for publication 2005.

Conference Publications

1. K.-H. Tan, J. Kobler, R. Feris, P. Dietz, and R. Raskar. Shape-Enhanced Surgical Visualizations and Medical Illustrations with Multi-Flash Imaging. In Proceedings International Conference on Medical Image Computing and Computer-assisted Intervention (**MICCAI**). 2004.
2. R. Feris, L. Chen, M. Turk, R. Raskar, K. Tan. Discontinuity Preserving Stereo with Active Illumination. IEEE International Conference on Computer Vision (**ICCV**) 2005, Beijing, Oct 15-21. Oral presentation.
3. R. Feris, M. Turk, R. Raskar, K.-H. Tan, and G. Ohashi. Exploiting depth discontinuities for vision-based fingerspelling recognition. IEEE Workshop on Real-Time Vision for Human-Computer Interaction (**RTV4HCI**), held in conjunction with **CVPR**. 2004.
4. Ning Xu, K.-H. Tan, H. Arora, and N. Ahuja. Generating Omnifocus Images Using Graph Cuts and a New Focus Measure. In Proceedings **ICPR**. 2004.
5. K.-H. Tan, D. Kriegman and N. Ahuja. Appearance-based Eye Gaze Estimation. In Proceedings of the IEEE Workshop on Applications of Computer Vision (**WACV**) 2002.
6. K.-H. Tan, H. Hua and N. Ahuja. Multiview mirror pyramid-based panoramic cameras. In Proceedings of the IEEE Workshop on Omnidirectional Vision (**OMNIVIS**), held in conjunction with the European Conference on Computer Vision (**ECCV**) 2002.
7. K.-H. Tan and N. Ahuja. A Representation for Image Structure and its Application in Object Selection with Freehand Sketches. In Proceedings IEEE Conference on Computer Vision and Pattern Recognition (**CVPR**) 2001.
8. K.-H. Tan and N. Ahuja. Selecting Objects with Freehand Sketches. In Proceedings IEEE International Conference on Computer Vision (**ICCV**) 2001.
9. K.-H. Tan and M. A. Lewis. Virtual Structures for Cooperative Mobile Robot Control. In Proceedings IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS**) 1996.
10. J. L. Zhen, K.-H. Tan and M. A. Lewis. Towards Universal Access to Robotic Resources. In Proceedings IEEE/RSJ International Conference on Intelligent Robots and Systems (**IROS**) 1996.

Technical Skills
Programming: MATLAB, C, C++, Objective-C, Visual C++, Visual Basic, Pascal, SQL.
Libraries: MFC, OpenGL, GLUT, FLTK, GLUI, OpenStep/Cocoa, X Motif, PVM, CORBA.
Platforms: Windows 95/98/NT/2000/XP, MacOS 9/X, Linux (Red Hat, PPC), Solaris, IRIX.

Machine Learning and Robotics Projects

Faceted Models for Nonlinear Subspace Modelling
One central issue in pattern and object recognition research is the learning and representation of nonlinear subspace manifolds that can capture complicated structures while retaining generalization capability. Efficient access to the modelled manifold is also critical for real world applications. I proposed an approach for constructing a graph-based piecewise linear model from small labelled sample sets, and applied it to object recognition and tracking. A parameterized version was use to solve a pose estimation problem. [5, Thesis]

Hexapod Walking Robot
Developed control system software for the Beckman Institute hexapod project that enabled the pneumatically-actuated robot to exhibit a walking gait for the first time, and is used to develop control strategies for the walking robot. The project is an interdisciplinary collaboration between the AI group and the Neuronal Pattern Analysis group at the Beckman Institute, and the hexapod remains a favorite exhibit at the annual Beckman Institute Open House.

Mobile Robot Formation Control
Developed distributed sysem that controlled the mobile robots via wireless LAN, and tracked the robots with an overhead camera. Developed control algorithm for accurate formation control of multiple mobile robots. The control algorithm was adopted by a NASA Jet Propulsion Lab group for controlling an experimental multiple-spacecraft system. [4, 9, 10]

Adaptive Neural Networks
Studied and compared the family of neural networks known as Adaptive Resonance Theory (ART) networks that presents a solution to the plasticity-stability tradeoff in learning systems. I implemented and compared the ART, ART-2, ART-3, ART-MAP, and FuzzyART networks and tested their performance on classic problems like the two-spiral data set. [BS Final Project]

Human-Computer Interaction Projects

Appearance-based Eye and Face Tracking
Developed an appearance-based method for estimating head pose and eye gaze direction, which represents a departure from conventional eye gaze estimation methods, the majority of which are based on tracking specific optical phenomena like corneal reflection and the Purkinje images. The algorithm is capable of estimating eye gaze with a mean angular error of 0.38 degrees, which is comparable to that obtained by commercially available eye trackers. The method can also be adapted to track faces while simultaneously giving an estimation of the user's head pose. [5]

Sketch-based Visual Object Selection
Developed technique for interactively extracting objects embedded in images and video using roughly drawn freehand sketches. The technique produces high-quality alpha channel mattes for the selected objects while allowing minimal, simple user input, and has applications in image and video editing, special effects and computer animation. This work has attracted interest from Adobe, Kodak, and Microsoft Research, requesting additional results, executables and source code. I was also awarded the Beckman Institute Graduate Fellowship for this work. [7, 8, http://vision.ai.uiuc.edu/~tankh/Selection]

Computer Vision, Graphics, and Image Processing Projects

Multi-flash Camera for Robust Depth Edge Detection and Comprehensible Rendering
Designed and built camera systems with multiple flashes that can recover high quality depth edges robustly. The system works even in situations where most traditional methods will fail, and is especially useful for capturing the 3D spatial structure of low-contrast, geometrically complex scenes. The depth edges recovered are then used to produce renderings that are easy-to-understand. The camera and the general method for depth edge recovery has many medical, industrial and consumer applications. [2, 1, 3]

Multiview Panoramic Video Camera
Mirror pyramid-based camera systems are a promising approach for video rate capture, as they offer single-viewpoint imaging, and use only flat mirrors that are easier to produce and introduce less optical aberration than curved mirrors. To date, the designs proposed typically capture panoramas from a single viewpoint. I proposed a method for generalizing existing designs such that multiple viewpoints can be created in a single mirror pyramid. This yields a compact design for simultaneous multiview panoramic video rate imaging, usable directly in augmented reality and telepresence applications. [1,6 http://vision.ai.uiuc.edu/~tankh/Camera]

Omnifocus Panoramic Camera with Programmable Depth of Field
Designed and built a Firewire-based camera that is capable of generating 360 degree panoramas, and with all objects in focus. Conventional cameras have a depth-of-field where objects near to a plane is in focus. The new camera can be programmed to generate images that exhibit a depth of field that can take an arbitrary shape and can be placed at arbitrary distances from the camera. The image processing software is accelerated using the NVidia GPU on the host computer and delivers the panoramic image in near realtime.

Multiscale Image Segmentation
Analyzed and enhanced an image segmentation algorithm based on a non-linear transform, capable of detecting image regions and edges at all photometric and spatial scales. I implemented a highly-optimized version of the algorithm that ran much faster than a previous prorotype, and the code is being used actively in the Beckman Institute Computer Vision and Robotics Lab in various ongoing research projects.

Depth from Focus using Graph Cuts
Optical defocus is one of the most salient depth cues available in images, and photographers and cinematographers have long exploited the finite depth of field of lenses to enhance the sense of depth in still and moving pictures. I formulated the problem as one of solving for an $s-t$ minimum graph cut. The algorithm is able to recover detailed depth maps from a set of images taken over a range of focus settings and also construct an *omnifocus* image. [4]

Fast Probabilistic Alpha Channel Estimation
Alpha channel estimation is a critical piece of technology used extensively in video production for pulling mattes and extracting objects for compositing. I derived a closed-form solution for the problem, which yields fast and efficient implementations that do not compromise quality. This allows alpha channel estimation to be incorporated into realtime and interactive applications. [Thesis]