

# ALUM Matters

*A newsletter for alumni of the Department of Computer Science*



Rakesh "Teddy" Kumar (top) and Harpreet Sawhney

## Kumar's and Sawhney's vision of the future

Rakesh "Teddy" Kumar ('92) and Harpreet Singh Sawhney ('92) joined the department (at that time called the Computer and Information Science Department) in Fall 1985 and worked under Professors Al Hanson and Ed Riseman. They defended their dissertations in Computer Vision just one day apart from each other. Currently they are both members of the Vision Technologies Division of Sarnoff Corporation in Princeton, NJ. Kumar is Senior Technical Director of the Vision & Robotics Laboratory, and Sawhney is the Technical Director of the Vision & Learning Laboratory.

"Vision activity at Sarnoff has grown from about a 20 person group in the early 1990s to a 140 person enterprise," says Sawhney. Kumar and Sawhney lead about half of this enter-

prise, directed by Dr. Peter Burt (UMass Amherst CS Ph.D. '76), Vice President of the Vision Technologies Division.

Kumar's and Sawhney's areas include applications such as aerial video surveillance, automotive, security, simulation and training, robotics, video data mining, and medical imaging. The application areas are vitalized by R&D in real-time video motion analysis, object detection and tracking, geo-registration, 3D motion and scene analysis, object and event recognition, video databases, multi-camera distributed sentient systems, and biometrics.

"A key technology developed at Sarnoff in the 1990s was precision alignment of motion video frames with parametric and non-parametric motion and structure models using multi-resolution pyramid-based direct methods,"

says Kumar. He experienced the power of these real-time methods when he worked with Sarnoff researcher Dr. Keith Hanna on online synthetic advertisement insertion in sportscast TV videos such as baseball and soccer.

The technical challenge was to automatically detect a pattern (a rectangular board) behind home plate in baseball in live videos from a broadcast quality pan-tilt-zoom camera. Subsequently, the synthetic billboard is warped onto the pattern and inserted into the live video while maintaining the foreground pixels from objects such as moving players. The alignment, segmentation, and insertion should happen in real-time with drift- and jitter-free broadcast quality. After refining the algorithms in the lab and in the field, the system was proven ready for use in sportscasts and was later commercialized by Princeton Video Imaging (PVI). PVI extended the technology to create the now famous yellow first down line in NFL football broadcasts.

The precision alignment technology was further honed by Kumar and Sawhney in their early work on video geo-registration. Geo-registration aligns video frames to a reference image database that contains geo-coordinates (i.e. latitude/longitude) for each pixel and assigns these coordinates to each pixel in the video frame (Figure 1: Video Georegistration). This research led to the development of a Sarnoff product, Terrasight™, for aerial video exploitation that is in use by the U.S. Department of Defense.

During the late 1990s, Kumar's and Sawhney's group commercialized VideoBrush, consumer software for creating real-time video and image sequence mosaics. It was one of the earliest mosaic tools to hit the market before digital cameras and camcorders became a reality. A memorable experience for the pair was showing off real-time mosaicking in the Sarnoff booth at COMDEX'97 (then the biggest computer show) and seeing people awed by the mosaic being painted on the big screen on the wall.

Kumar and Sawhney took on the challenge of designing a tool for IMAX to create binocular large-format 3D movies while avoiding the use of two mini-refrigerator sized IMAX cameras. The goal was to use a binocular image sequence in which one stream is captured at the typical IMAX resolution of 8Kx6K pixels while the second stream is only captured at 2Kx1.5K, 1/16th of the original. "The problems of precision alignment between streams of binocular frames using high quality stereo and

## Alumni Connections

**Daniel Bernstein** (Ph.D. '05) received Honorable Mention for the ICAPS Best Dissertation Award. ICAPS runs the premier conference on Automated Planning & Scheduling. The 2007 award is for dissertations completed in the previous two years. One award winner and three honorable mentions were selected. The awards committee noted Bernstein for "his highly innovative research on planning under uncertainty for multiple agents introducing and characterizing a new framework of decentralized MDPs."

**Jeff Bonar** (Ph.D. '85) is the founder and chairman of JumpStart Wireless. Bonar's Florida-based company developed applications that can be used on wireless devices such as cell phones and email systems to transmit data from the worker in the field back to the office, thus eliminating paperwork and improving productivity. His work was recently highlighted in the media nationwide.

Baystate Scholar **Hee-Jin Chae** (M.S. '07) joined Raytheon after presenting her RFID security research in Spain.

After five years in Chicago as an Andersen Consulting (now Accenture) Senior Consultant in the New Age Systems Group, **Jen Hall** (B.S. '90) left to become an Outward Bound instructor. She climbed trees and coached effective teams for five years before getting back into technology as a freelance web programmer. She is currently the Director of Internet and Web Development of Conover Tuttle Pace ([www.ctpboston.com](http://www.ctpboston.com)). Hall is also a volunteer firefighter and a single mom having recently adopted a baby boy.

Former CS student and Teaching Assistant (TA), **Jedidiah Mitchell** participated in the FJORG! 32-hour iron animator event at SIGGRAPH in San Diego. While at UMass Amherst, Mitchell was a TA for Prof. Beverly Woolf's animation course, and he worked in the Center for Computer-Based Instructional Technology (CCBIT). Mitchell is the son of CS staffer Gwyn Mitchell.

**Ramachandran Ramjee** (Ph.D. '97) has moved from Lucent Bell Labs to Microsoft Research in Bangalore, India. He is a Senior Researcher in the Mobility, Networks, and Systems Group. Ramjee's research interests are in architecture, protocol, and performance issues in next generation wired and wireless networks.

Carnegie Mellon University Professor **Tuomas Sandholm** (Ph.D. '96) was highlighted in the *Pittsburgh Post-Gazette* for creating a system to match living kidney donors with potential recipients.

**Steven Willis** (B.S. BDIC '78) joined the Board of Advisors for PlumChoice, a leader in remote technology services for the home and small office. He has been a pioneer in developing core Internet technologies for more than 20 years. He co-founded Wellfleet Communications, a pioneering Internet router company, and started Wellfleet's Advanced Engineering Group, which developed key Internet and ATM standards and technologies. In 2001, he joined Datapower as vice president of advanced technology and drove the development of a high-performance, hardware-based XML processor.

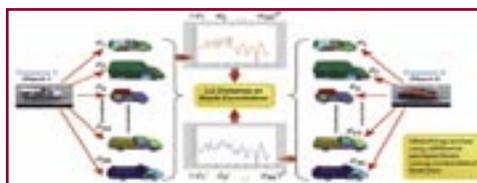
motion processing, and rendering with color and motion artifact correction, were solved through persistence and experimentation," says Sawhney. "The satisfying moment came when a blind test of real and synthesized 3D movie clips projected in a 3D IMAX theater revealed no perceptible differences between the real and synthesized data." (Figure 2: IMAX).

Starting in 2000, Kumar's and Sawhney's team started working on multi-camera distributed systems for large area situational awareness applications. This work includes 3D contextual visualization of numerous camera videos, tracking and classification of vehicles and humans, cross-camera association and tracking, and real-time forensic database querying and alerts. Working in a close-knit team

with Sarnoff's Keith Hanna, Supun Samarasekera, Manoj Aggarwal, and others, Kumar and Sawhney commercialized a multi-camera platform for wide area situational awareness called VideoFlashlights (Figure 3: videoflashlights) and video-based analytics called VisionAlert. "This platform started as a research prototype in the lab and was deployed as a pilot system at a number of airports and other installations before Sarnoff licensed it for commercialization," says Sawhney.

During the early part of this decade, Kumar and Sawhney started foundational work on 3D light detection and ranging (lidar) and video based object recognition, 3D navigation, mapping, and modeling. Kumar's group

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(left-rt) top row: (1) Video Geo-registration, (2) IMAX image-based rendering, (3) VideoFlashlights. Bottom row: (4) 3D Lidar based real-time vehicle recognition, (5) Visual Mapping and Localization, (6) Vehicle Querying.

### Robot contest

Led by Brian Pinette (Ph.D. '94; pictured here, far left), the Frontier Regional High School Robotic Club in South Deerfield, MA, placed second in the world in the 14th Annual International Trinity College Firefighting Home Robot Contest. Pinette, a Senior Research Fellow in the department, advised a team of students who competed regionally against U.S. teams before reaching the international competition. Their robot, named Buffalo, successfully maneuvered through a maze to extinguish two "fires" and locate a baby trapped in a simulated home.

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#### KUMAR / SAWHNEY - continued from previous page

developed a system called SiteMaker which can automatically build 3D models of scenes (800 sq km in less than a day). Later Sawhney's group developed algorithms and real-time systems for precision recognition and fingerprinting of vehicles from a database of hundreds of vehicle models (Figure 4: lidar). Furthermore, object classification of pedestrians and vehicles in roadside scenes captured from moving vehicles is an active area of R&D for automotive and robot safety applications.

In addition, Kumar's group has created a real-time system for precision localization of mobile platforms with better than 0.1% drift over kilometers of distance traveled (Figure 5: visualmapping). "This technology is creating a lot of excitement especially in applications where localization in GPS-free environments is critical such as in urban canyons and indoors," says Kumar.

Sawhney's group is also active in large-scale video databases that combine real-time video processing with creation of objects, tracks, and events as database entities. The databases are connected with systems for geo-spatial visualization, querying, and video forensics (Figure 6: vehiclequerying).

Kumar's and Sawhney's experience with Professors Hanson and Riseman instilled in them a sense of the complexities and excitement of dealing with real-world problems. "Sarnoff has provided us a playing field where cutting edge R&D and real-world systems are both actively worked on to push the frontier of knowledge as well as make a difference in the world with technology. The future holds a lot of promise for vision at Sarnoff and vision at large," notes the team. Robotics is maturing with sensing and perception as key components. "My dream of creating a robot with vision that my wife would love to buy will be realized within the coming decade," says Kumar.

"The UMass Amherst Vision group of the late 80s with Ed and Al at the helm motivated us to address challenging problems and gave us the stamina to work on them with perseverance," say Kumar and Sawhney. The experience of those heady days extended into the conceive-create-deploy-refine cycle at Sarnoff that has created a unique lifestyle for Kumar and Sawhney in the prime of their careers.

### Where have they gone?

The following computer science students have graduated with Ph.D.s from UMass Amherst within the past year:

**Brendan Burns:** "Exploiting Structure: A Guided Approach to Sampling-Based Robot Motion Planning" (Oliver Brock, Advisor); Assistant Professor, Union College.

**Jamieson Cobleigh:** "Automating and Evaluating Assume-guarantee Reasoning" (Lori A. Clarke, Advisor); Software Engineer, The MathWorks.

**Jiwoon Jeon:** "Searching Question and Answer Archives" (W. Bruce Croft, Advisor); Software Engineer, Google Inc.

**Purushottam Kulkarni:** "SensEye: A Multi-tier Heterogeneous Camera Sensor Network" (Prashant Shenoy and Deepak Ganesan, Advisors); Assistant Professor, I.I.T. Bombay.

**Wei Li:** "Pachinko Allocation: DAG-Structured Mixture Models of Topic Correlations" (Andrew McCallum, Advisor); Senior Software Development Engineer, Yahoo! Inc.

**Donald Metzler:** "Effectively Modeling Term Dependencies in Information Retrieval" (W. Bruce Croft, Advisor); Research Scientist, Yahoo! Research.

**Hema Raghavan:** "Tandem Learning: A Learning Framework for Document Filtering" (James Allan, Advisor); Research Scientist, Yahoo! Applied Research.

**Jiaying Shen:** "Communication Management in Distributed Sensor Interpretation" (Victor Lesser, Advisor); Computer Scientist, SRI International.

**Kyoungwon Suh:** "Monitoring, Measurement, and Control of Multimedia Traffic in IP Networks" (James Kurose and Donald Towsley, Advisors); Assistant Professor, Illinois State University at Normal.

**Xing Wei:** "Topic Models in Information Retrieval" (W. Bruce Croft, Advisor); Research Scientist, Yahoo! Research.

**Xiaolan Zhang:** "Routing in DTN: Performance Modeling, Network Coding Benefit and Real Trace Studies" (James Kurose and Donald Towsley, Advisors); Assistant Professor, Fordham University.