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 enterprise, 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
Working in a close-knit team, Kumar 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 continued on next page
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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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.


**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.