SENSOR NETWORKS –
The New Environment

7th IEEE/NATEA Annual Conference
New Frontiers in Computing Technology, 2005

Braun Auditorium, Stanford University
Saturday, May 7th, 2005

Conference Chairs: Michael Graebner and Belle Tseng
Program Chairs: Yen-Kuang Chen and Eaden Saw
Operation Chairs: Jessy Hsu and Porter Wong
Publicity Chairs: John Huang and Tom Schwartz

Keynote Title: An Introduction to Sensor Networks
Professor Leonidas Guibas, Stanford University

Abstract: The distribution of networked sensors in the environment offers exciting new possibilities for sensing and monitoring. Sensors can be placed close to multiple signal sources so that, collaboratively, they can sense and reason about wide-area phenomena, while providing a distributed awareness that no centralized system can attain. To bring this vision to fruition, however, several technological challenges remain. The network needs to discover its own resources and structure using local exchanges among the nodes and then proceed to aggregate information as needed, in order to accomplish its overall mission. This must be done in a scalable and robust way that allows systems with a large and variable number of relatively frail nodes to operate even in the presence of uncertainty and incomplete information.

The talk will introduce the key hardware and software aspects of sensor networks and highlight some of the central ideas used infrastructure establishment, routing, information brokerage, and data storage.

Leonidas Guibas obtained his Ph.D. from Stanford in 1976, under the supervision of Donald Knuth. His main subsequent employers were Xerox PARC, MIT, and DEC/SRC. He has been at Stanford since 1984 as Professor of Computer Science, where he heads the Geometric Computation group within the Graphics Laboratory. He is also part of the Artificial Intelligence Laboratory and the Bio-X Program. Professor Guibas'
interests span computational geometry, geometric modeling, computer graphics, computer vision, robotics, ad hoc communication and sensor networks, and discrete algorithms --- all areas in which he has published and lectured extensively. At Stanford he has developed new courses in algorithms and data structures, geometric modeling, geometric algorithms, sensor networks, and biocomputation. Professor Guibas is an ACM Fellow.

Title: An Application and Technology Framework for Wireless Sensor Networks
John Suh, PhD, Senior Application Engineer, Crossbow Technology

Abstract: This talk presents an applications and technology framework for sensor networks, particularly those based on Crossbow's MICA-series Motes. There are a variety of sensor network applications. However, there are common set of reasons or themes behind those applications. In terms of technology the hardware can be classified into four types according to the sensing requirements: application-specific sensor devices, general-purpose sensor nodes, high data-rate sensor nodes, and

sensor network interfaces to LAN (Gateways). In addition, a new software framework is essential for sensor networks. Traditional networking protocols do not provide the power-saving that facilitate battery powered operation.

John Suh is an Applications Engineer at Crossbow Technology, Inc. He has a PhD in Mechanical Engineering from Stanford University where he did research in MEMS.

Title: Target Tracking and Surveillance Using Sensor Networks
Professor Prasant Mohapatra, University of California – Davis

Target tracking and surveillance are two very important applications of wireless sensor networks. In this talk we will discuss two novel approaches - one for target tracking, and the other for surveillance - using sensor networks. We first propose and derive a metric to quantify the quality of surveillance, which is applicable for both the application scenarios. Our approaches are designed taking the power saving operations into consideration, which is of critical importance for extending network lifetime. In target tracking applications, the sensor nodes collectively monitor and track the movement of an event or object. We propose a collaborative messaging scheme that wakes up and shuts down the sensor nodes with spatial and temporal preciseness. This study, which is a combination of theoretical analysis and simulated evaluations, quantifies the trade-off between power conservation and quality of surveillance while presenting guidelines for efficient deployment of sensor nodes for target tracking applications. In the second part of the talk, we propose patrol-based surveillance approaches. A new framework, called SENSTROL, is proposed that provides energy-efficient patrolling in any desired path or regions in an on-demand manner. The implementation and the operational behavior of the framework will be demonstrated.

Dr. Prasant Mohapatra is currently a Professor in the Department of Computer Science at the University of California, Davis. He has also held various positions at Iowa State University, Michigan State University, Intel Corporation, Panasonic Technologies, Institute of Infocomm Research, Singapore, and the National ICT, Australia. Dr. Mohapatra received his Ph.D. in Computer Engineering from the Pennsylvania State University in 1993. He was/is on the editorial boards of the IEEE Transactions on computers, ACM/Springer WINET, and Ad hoc Networks Journal. He has served on numerous technical program committees for international conferences, and served on several panels. He was the Program Vice-Chair of INFOCOM 2004, and the Program Co-Chair of the First IEEE International Conference on Sensor and Ad Hoc Communications and Networks, (SECON-2004). Dr. Mohapatra's research interests are in the areas of wireless networks, sensor networks, Internet protocols and QoS.

Dr. Frank Hsu
Chair, Dept. of Computer and Information Science, Fordham University
Editor-in-Chief, Journal of Interconnection Networks

Afternoon Keynote:
WLAN Enabled Cellphones: Why Integration is Inevitable
Professor H.T. Kung, Harvard University, Computer Science and Electrical Engineering

It is increasingly evident that the growth of wireless local access networks (WLANs) based on 802.11x standards like Wi-Fi will soon be massive and widespread. This talk argues that WLAN enabled cellphones will be a convergence point for networking, computing and sensing. Some industrial efforts on these many-in-one cellphones will be described. Possible future directions related to emerging wireless technologies such as WiMAX will also be discussed.

H.T. Kung is William H. Gates Professor of Computer Science and Electrical Engineering at Harvard University. He received his Ph.D. from Carnegie Mellon and served on its faculty before joining Harvard in 1992. Dr. Kung has pursued a variety of interests over his career, including complexity theory, database theory, VLSI design, parallel computing, computer architectures, computer networks, and network security. Since 1999, Dr. Kung has been co-chairing a joint Ph.D. program in information, technology and management with the Harvard Business School. In addition to his academic activities, he maintains a strong link with industry by serving as a consultant and board member to numerous companies. Dr. Kung is a member of National Academy of Engineering in US and Academia Sinica in Taiwan.

Video Sensor Networks: HW, SW and some Algorithms
Dr. Gary Bradski, Manager – Machine Learning Group, Intel Corporate Technology

Abstract:

Cameras are in many ways the most challenging sensor to deal with in sensor networks, not only in terms of the large amount of data they produce, but also because of the computational complexity per sensor necessary to convert the camera's 2-D grid of varying light patterns into meaningful objects: person, tree, car and so on. One would also hope to coordinate information across cameras to take advantage of stereo views or to track objects across cameras. Thus we face problems of hardware to support the data flow and synchronization of many cameras and software that can manage the datasets and turn the images into useful information. In this talk I will describe advances that allow progress on all these fronts.

On the hardware front a new company, SensorCast, has developed a system in which you can drive from 16 to 256 cameras per server in lines of 16 each. An early prototype of this system has recently been installed in Gates Hall at Stanford. In this system, any two cameras on each line of 16 cameras can by fired together to yield stereo information. Camera sampling can be uniform or concentrated among a group of cameras depending on information needs. The server stores the image and also acts as a video server over a network and can also serve video or statistics to a cell phone.

On the Software front, this system employs Intel's vision library, OpenCV, for background segmentation and Kalman tracking. Further support for object class recognition (person, cart, bike …) and identification (which person) is underway using OpenCV's new machine learning library (MLL) functions. Together, this system provides the basis for higher level work in such areas as fusion of sensor data in probabilistic world models, behavioral statistics, and information based sampling.

Bio:
Gary Rost Bradski is a Principal Engineer and Manager of the Machine Learning group for Intel Research. His current interests are hierarchical learning-based vision methods and sensor fusion in world models. Gary received a B.S. degree from U.C. Berkeley in May, 1981.
He received his Ph.D. degree in Cognitive and Neural Systems (mathematical modeling of biological perception) in May, 1994 from Boston University Center for Adaptive Systems. He started and directed the popular Open Source Computer Vision Library (OpenCV) as well as the Machine Learning Library (MLL) due out under the OpenCV source tree shortly. He also started the Probabilistic Network Library (PNL) currently in Beta on Source Forge. He's currently on sabbatical at Stanford University AI department.

Gary Bradski received his BS from UC Berkeley in Electrical Engineering, worked and consulted some years in the security and medical industry prior to getting his PhD in mathematical modeling of learning and perception in the brain from Boston University. He worked awhile creating interest rate options on First Unions derivative securities trading floor before moving back to Intel to run a computer vision and now machine learning research group.

System Challenges for Designing a Zigbee Baseband Chip
Dr. Kuor-Hsin Chang, Senior System Architect, Freescale Semiconductor

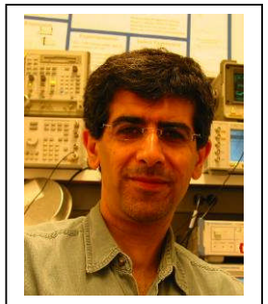
Abstract: The talk starts with the introduction of the physical layer system specification in IEEE802.15.4 standard. Then we will discuss the challenges of designing a cost-effective SoC platform for Zigbee that can address various application requirements.

Dr. Kuor-Hsin Chang currently is a Sr. System Architect working on Freescale's next generation Zigbee platform. He has ten years of development/application experience in the wireless/semiconductor industry working on emerging wireless standards in cellular, fixed-point wireless (WiMAX), Wireless Personal Area Network (WPAN), and Wireless Local Area Network (WLAN).

Dr. Chang was a project lead at Quicksilver Technology developing wireless/multimedia applications based on ACM (Adaptive Computing Machine) architecture. He was a Staff Engineer for VLSI/Philips and a Sr. System Engineer for NEC Electronics developing CDMA baseband chip. Dr. Chang also held various management and business development positions in several start-ups focusing on cutting-edge wireless products. Dr. Chang's current interests are flexible hardware architecture for wireless baseband, efficient platform that supports various wireless applications and wireless applications that improves the quality of human life.

Dr. Chang received his Ph.D. in Electrical Engineering from Texas A&M University, College Station, Texas, and his B.S. in Telecommunication Engineering from National Chiao-Tung University, Taiwan.

Emerging Applications of Wireless Sensor Networks
Professor Hamid Aghajan, Stanford University



Abstract:
Energy and bandwidth constraints are major concerns in developing applications in wireless sensor networks. Hence, most traditional applications in this field are designed to deal with input data that is of low-bandwidth nature. In this talk we examine the possibilities in using high-bandwidth input data while the network communication is maintained at low-bandwidth levels. In particular, we will provide examples of how on-board computing and collaborative processing

techniques can be employed to address problems in network self-organization and tracking applications using distributed image sensors. Several hardware and software platforms developed at the Wireless Sensor Networks Lab at Stanford University that enable efficient algorithm development and testing for these applications will also be introduced.

Biography:
Hamid Aghajan is a consulting professor in the Department of Electrical Engineering at Stanford University, where he has helped establish and now supervises the Wireless Sensor Networks Laboratory with sponsorship of Professor Andrea Goldsmith. Hamid has ten years of industrial experience in algorithm design for application domains in wireless communications, optical telecommunications, biotechnology, and semiconductor manufacturing industries. He was a co-founder of a start-up company in 2001, and has also served on the Board of Advisors of high technology companies active in various wireless sensor networks applications.

Hamid is currently supporting research programs of a group of students at Stanford University on various aspects of wireless sensor networks with an emphasis on decentralized and collaborative processing methods for automated network node localization, applications of wireless image sensor networks, and RFID-enabled networks. In addition, he is supervising the development of several hardware and simulation platforms at the lab, including the design of two new wireless motes enabling further research in this field. Hamid has published numerous journal and conference papers and holds 5 US patents. He has a Ph.D. degree in Electrical Engineering from Stanford University.

Morning Program	
8:00am-9:00am	**Registration**
9:00am-9:15am	**Opening Remark by Conference Chair** *Michael Graebner* IEEE Computer Society Vice-Chair
9:15am-10:00am	**Keynote: An Introduction to Sensor Networks** *Professor Leonidas Guibas* Computer Science Department, Stanford University
10:00am-10:45am	**Application & Technology Framework for Wireless Sensor Networks** *Dr. John Suh* Senior Application Engineer, Crossbow Technology
10:45am-11:00am	**Break**
11:00am-11:45am	**Target Tracking and Surveillance Using Sensor Networks** *Professor Prasant Mohapatra* Computer Science Department, University of California – Davis
11:45pm-12:30pm	**Title** *Professor Frank Hsu* Chair, Dept. of Computer and Information Science, Fordham University
12:30pm-1:30pm	**Lunch Break**

Afternoon Program	
1:30pm-2:15pm	**Keynote: Wireless LAN Enabled Cellphones: Why Integration is Inevitable** *Professor H.T. Kung* Computer Science and Electrical Engineering Dept, Harvard University
2:15pm-3:00pm	**Video Sensor Networks: HW, SW and some Algorithms** *Dr. Gary Bradski* Manager, Intel Corporate Technology
3:00pm-3:15pm	**Break**
3:15pm-4:00pm	**System Challenges for Designing a Zigbee Baseband Chip** *Dr. Kuor-Hsin Chang* Senior System Architect, Freescale Semiconductor
4:00pm-4:45pm	**Emerging Applications of Sensor Networks** *Professor Hamid Aghajan*

	Electrical Engineering Department, Stanford University
4:45pm-5:00pm	**Program Closing**