Sensor Networking for Detection
From Distributed Detection to Energy Savings and MIMO Radar

Rick S. Blum
ECE Dept.
LEHIGH UNIVERSITY

Many collaborators & students contributed to the work discussed, see research papers

Prof. Blum is looking for outstanding postdocs and graduate students to work on signal processing (detection and estimation) for smart grid (sensor networking).

Example Project: Intrusion and failure detection of smart grid. Measurement device (sensors) data is inconsistent with system model.

http://www.ece.lehigh.edu/SPCRL/ rblum@lehigh.edu
Lehigh has a strong Research Group focused on smart grid which I lead.

Lehigh has a strong Research Group in Signal Processing and Communications including:

Rick S. Blum: Signal Processing (Detection/Estimation) and Communications for Smart Grid and Sensor Networks.  
http://www.ece.lehigh.edu/SPCRL/spcrl.html

Shalinee Kishore: Communications, Networking, Smart Grids  
http://www.ece.lehigh.edu/~skishore/

Tiffany Jing Li, coding for communication and storage systems, signal processing and distributed algorithms for networked systems  
http://www.ece.lehigh.edu/~jingli/

Parv Venkitasubramaniam: Information Security, Distributed Statistical Inference  
http://www.lehigh.edu/~pav309/parv.html

Zhiyuan Yan: error control coding,  
http://www.ece.lehigh.edu/~yan/

ECE Dept: http://www.ece.lehigh.edu/

---

IEEE SPS Mission Statement

The Signal Processing Society is an international organization whose purpose is to:

- advance and disseminate state-of-the-art scientific information and resources
- educate the signal processing community
- provide a venue for people to interact and exchange ideas

(Adopted by SPS Board of Governors 11 September 2003)
SPS Chapters

Chapter Support:
- SPS provides annual support up to $500 per Chapter for coffee breaks or other small social gathering expenses.
- SPS provides an annual allotment up to $3,500 per Chapter for use of the Society’s Distinguished Lecturer Program. The annual allotment can be used toward SPS appointed Distinguished Lecturers or pre-approved invited lecturers.
- The current list of SPS Distinguished Lecturer Program can be found on the web at: http://www.signalprocessing.org/lecturers/distinguished-lecturers/
Sensor Networking

- Military systems frequently employ sensors connected by communication networks.
- Becoming more popular in commercial applications.
- Trend towards simple, less expensive, sensor nodes carrying their own power connected by wireless networks.

Outline

What do we mean by “Sensor Networking for Detection”?
- Example applications

- Distributed Detection
  - Problem definition
  - Review of some results

- Energy Savings
  - Goal and censoring approach
  - New ordering approach

- MIMO Radar
  - Network of radars concept
  - Diversity and resolution gains
Sensor Fusion Algorithms

Advanced Comm. Technology

Multiple Antenna Comm (MIMO)

Advanced imaging sensors

Trend toward UAVs: MIMO Radar

Sensor Networking Ad hoc Networking

SAR/Radar/MMW cameras

Numerous Other Non-military Applications

Weather monitoring

Bioimaging, biosciences: Cell imaging

Animal monitoring

Structure monitoring
UMASS Distributed Radar

Nanotechnology: Small Sensor Trend

- Development of signal processing for large array of nanotechnology-based sensors to detect chemical leaks.

Interdigitated electrode structure for chemical sensors.
All these applications (and many others) attempt to solve a hypothesis testing problem

- $H_0$: $f_0(x_1,\ldots,x_N|H_0)$ is joint pdf of observations at sensors one through $N$
  
  versus

- $H_1$: $f_1(x_1,\ldots,x_N|H_1)$ is joint pdf of observations at sensors one through $N$

- Probability of error = Prob(we choose wrong) = $P_e$