Sensornets and Related Research at WiSe Lab

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Smart Sensors
What are they?

Micro-sensors +
on board processing +
low-power wireless interfaces

➡ All feasible at very small scale

- Berkeley Motes
- MIT µAMPs
- Sensoria WINS
- Hidra

Smart Sensor Node H/W-S/W Platforms

Energy efficiency is the crucial h/w and s/w design criterion
A Smart Sensor Network System

- Smart Sensors
- Base Station
- Command Center
- Supervisor Sensor
- Satellite

New Applications Enabled by Wireless Sensor Networks

- RFID Applications
- Monitoring Environments
- Monitoring Structures and Things
- Interactive Environments
- Industrial Monitoring
- Control Networks
- Precision Agriculture

Applications in All Aspects of Life

- Process monitoring and control
- Firefighting and rescue
- Structure and earthquake monitoring
New Design Themes

- Long-lived systems that can be untethered and unattended
  - Low-duty cycle operation with bounded latency
  - Exploit redundancy and heterogeneous tiered systems
- Leverage data processing inside the network
  - Thousands or millions of operations per second can be done using energy of sending a bit over 10 or 100 meters (Pottie00)
  - Exploit computation near data to reduce communication
- Self configuring systems that can be deployed ad hoc
  - Un-modeled physical world dynamics makes systems appear ad hoc
  - Measure and adapt to unpredictable environment
  - Exploit spatial diversity and density of sensor/actuator nodes
- Achieve desired global behavior with adaptive localized algorithms
  - Can’t afford to extract dynamic state information needed for centralized control

From Embedded Sensing to Embedded Control

- Embedded in unattended “control systems”
  - More than control of the sensor network itself
  - Different from traditional Internet, PDA, Mobility applications
- Critical applications extend beyond sensing to control and actuation
  - Transportation, Precision Agriculture, Medical monitoring and drug delivery, Battlefield applications, Military/Defense Applications
  - Concerns extend beyond traditional networked systems
    - Usability, Reliability, Safety, Security
- Need systems architecture to manage interactions
  - Current system development: one-off, incrementally tuned, stove-piped
  - Serious repercussions for piecemeal uncoordinated design: insufficient longevity, interoperability, safety, robustness, scalability...
**Smart Sensor Network System Building Blocks**

- Network Self-Organization
- Theoretical Framework
- Node Localization
- Mobility and Navigation
- System Energy Management
- Human Interface
- Programming Models
- Communication Links
- Target Identification Algorithms
- Actuation
- Sensors
- Calibration
- Database Policies and Architecture
- Connection to Infrastructure
- Cooperative Detection
- Modeling of Environment
- Communication Links
- Connection to Infrastructure
- Cooperative Detection
- Modeling of Environment
- Target Identification Algorithms
- Actuation
- Sensors
- Database Policies and Architecture
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**WMU R & D Projects**  
(January 2003 – present)

1. Design of Security, Privacy & Trust Protocols
2. Intrusion Detection
3. Localization
4. Classification
5. Remote Home Surveillance
6. Collective Image Processing
7. DENS: a Development Environment for Networked Sensors
8. Incorporating mobile-ware in distributed computations / computational-grid
9. Energy efficient MAC protocols for IEEE 802.11x
10. Mobile and Self-calibrating Irrigation System
11. Collective communications for sensornets
12. Collaborative Signal Processing
13. Opportunistic Networks
14. Service Deployment, Registration & Management
15. Condition-Based Maintenance
16. Glucose Monitoring