Sensor net applications
Class wrap-up
Project presentations

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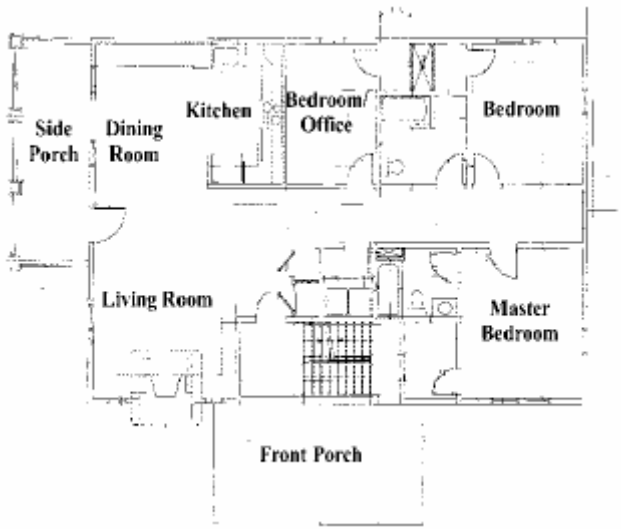
Application papers

- Kidd et al., “The aware home: a living laboratory for ubiquitous computing.”
- Cerpa et al., “Habitat monitoring: application driver for wireless communications technology.”
- Mainwaring et al., “Wireless sensor networks for habitat monitoring.”

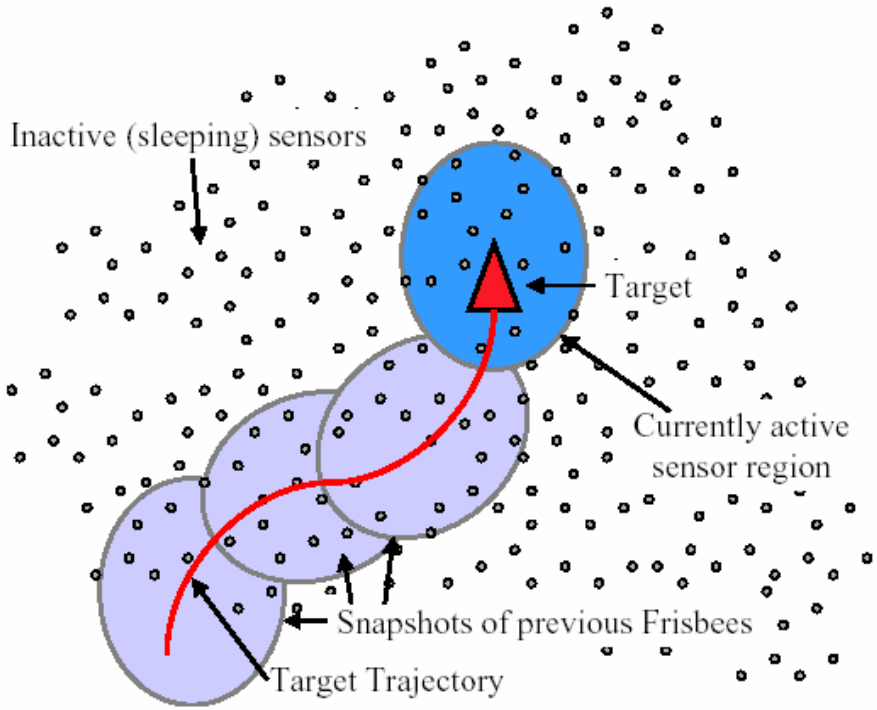
A vision for smart homes [Kidd99]

- Application: elderly care in an assisted living env
- Issues
  - Context awareness
  - Interaction and behaviors
  - Privacy
- Technologies
  - Smart floor
  - RFID to tag objects
  - Wearable computers



Monitoring bio-diversity [Cerpa01]

- Intended app: bio-complexity mapping
- Issues
  - power usage concern
  - Physical embeddedness
  - In-network processing and self configuration
- Technology components
  - Node wakeup
  - Node discovery and services
  - HW platforms: PC104 vs. RFID tags



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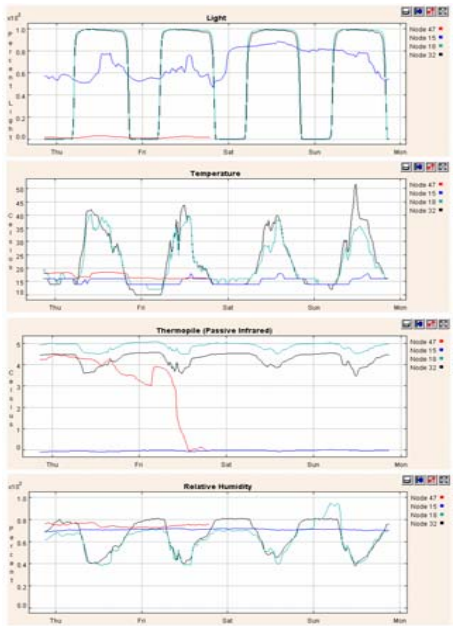
Habitat monitoring on GDI [Mainwaring02] www.greatduckisland.net

Great Duck Island, 10 miles off the coast of Maine:

Remote wireless sensors are being used to find out more about birds in their natural habitat.

Petrel: Rarely seen by birdwatchers

Wireless biological sensors placed in nests



"It will enable us to study ecosystems at a level that has not been conceived."
Steve Katona, College of the Atlantic biologist and president

BBC News, October 10, 2002

Desiderata in designing sensor net applications

- Understand application characteristics
  - Physical phenomena and coupling → sensing modality
  - Stationary vs. dynamic stimuli
  - Local vs. no-local phenomena
- Understand task requirements
  - Localization vs. tracking
  - Detection and classification
  - Information delivery vs. gathering
  - Accuracy, misses/false alarms, latency, network dewell time
- Understand environmental constraints
  - Infrastructure vs. infrastructure-less
  - Instrumented vs. ad hoc deployment
    - » Examples: monitoring hazardous spills in an inaccessible area vs. security cameras at airport
  - Indoor vs. outdoor (weather proof)
  - Mobile vs. stationary nodes
- Understand system constraints
  - Cost and size considerations
  - Node capabilities (motes vs. general embedded linux box)
  - Battery operated vs. power-line
  - Radio range and communication protocols
  - One-shot vs. long-running systems

Review of the lectures

- Sensor tasking and control
  - Lectures 1, 2 and 9: tracking as a canonical problem, probabilistic formulation, IDSQ, relational reasoning, multi-camera tracking
- Network discovery and initialization
  - Lecture 5: location discovery and maintenance, time synch
- Data aggregation and routing
  - Lectures 3 and 4: directed diffusion, geo and energy-aware routing, optimal node density/RF range
- Information management
  - Lectures 6 and 7: TinyDB and SQL-style querying, GHT and data-centric storage, range query, clustering
- Physical constraints
  - Lectures 1 and 8: energy constraints, energy-efficient routing, embedded OS (TinyOS and TinyGALS)

Some of the fundamental issues we've discussed

- Optimally direct resources towards tasks in hand
  - Information utility, resource (bandwidth, sensing, and processing) constraints, task objectives, usage requirement:
    - » E.g., directed diffusion, IDSQ, relational tracking
  - Resource allocation becomes a distributed constrained optimization
- Design networked embedded systems together with applications
  - Break barriers between applications, networking, database querying etc.
    - » E.g. Data routing and aggregation informed by tasks such as tracking
    - » E.g. Query processing as part of collaborative in-network signal processing (how many targets are there?)

Fundamental issues (continued)

- Organize network to match task structures
  - Cache information to support efficient querying and update
    - » E.g., KDS
  - Reconfigure network as requirements or conditions change
    - » How often? Are changes predictable?
    - » How to locate and mitigate faults?
- Issues we have not explored as much
  - Fundamental limits of sensor networks
    - » “Network capacity” theorem for a sensor net
      - Is it information transport, detection, # of independent tasks to support?
  - Security and privacy for sensor networks
    - » How to prevent malicious injection of bogus data
      - Need lightweight authentication
    - » How to ensure privacy in a pervasive sensing world?

Class project presentations

- Rahul Biswas, Finding convex hulls of agents with sensor networks
- Dileep George and Ritesh Madan, Efficient path update algorithms for mobile nodes in a wireless ad hoc sensor network
- Jeffery Wu, Sensor node localization
- An Nguyen, Niloy Mitra, and Jaewon Shin, Mobile user localization using IEEE 802.11b WAPs