Partisans: Participatory Sensing @ CENS

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Some lessons from ENS research…

Early themes

Thousands of small devices

- Minimize individual node resource needs
- Exploit large numbers

Fully autonomous systems

- In-network and collaborative processing for **longevity:** optimize communication

New themes

Heterogeneity

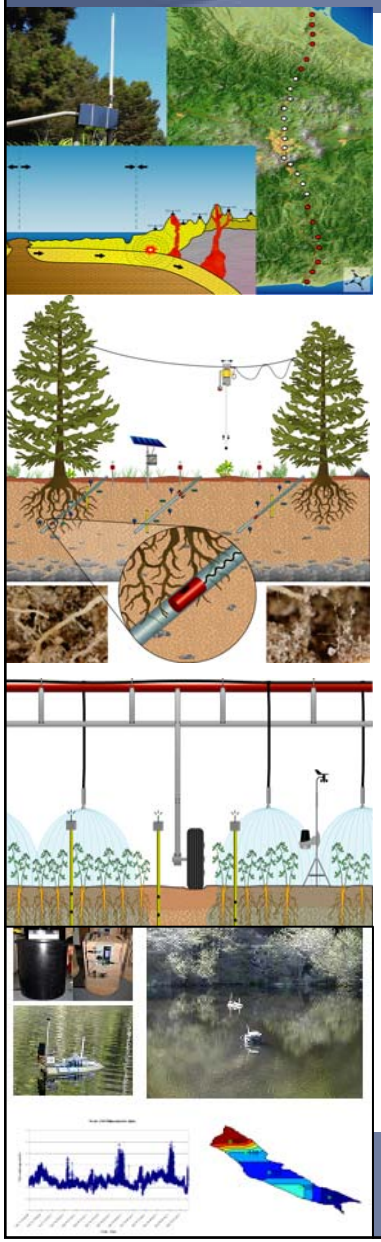
- Tiered systems: optimize system as a whole
- Inevitable under-sampling (in time or space)
- Exploit multiple modalities, multiple scales, and *mobility*

Interactivity

- Design for human tier as well…online interaction and tasking
- In-network and collaborative processing for **responsiveness data quality, and data control (privacy):** optimize sensing
- Monitoring the monitors: **calibration, self test, validation**

Participatory Sensing

CENTER FOR EMBEDDED NETWORKED SENSING



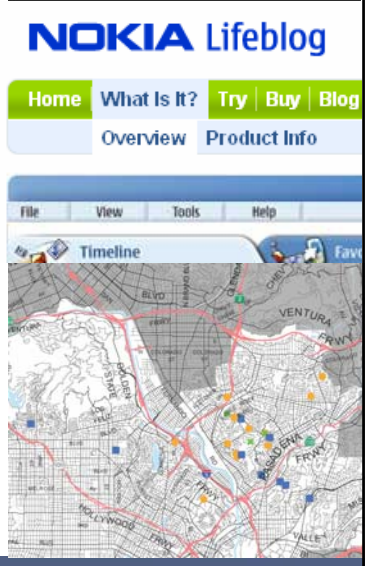
← **ENS is revealing the previously unobservable in science applications**

Multi-scale data and models to achieve context, and in network processing and mobility to achieve scalability (communication, energy, latency)

Automatically geocoded and uploaded participatory sensing data promises to make visible human concerns that were previously unobservable…or unacceptable →

Urban sensing applications will leverage the millions of cell phone acoustic, image and bluetooth-connected sensors

Internet search, blog, and personal feeds, along with automated location tags, to achieve context, and in network processing for privacy and personal control



Technical themes draw from sensornets and internets

Explore system needs and opportunities

Multiscale sensing and actuation	…to achieve **Coverage**
In-network processing	…to support **Privacy**
Analysis and visualization	…to enable **Discovery**

Define architectural elements and interfaces

Sensor	Observe, capture, forward
Network	Name, verify, tag with context
Fabric	Filter, search, store, disseminate
Application	Explore, task, re-present

Range of Application Types

'Directed' sensing applications

- Eco-PDA
  (*space/time-tagged annotation*)
- Self-administered health diagnostics
  (*auto-upload, verify context*)
- Public/community health
  (*spatial interface to data, data-gathering-protocol authoring*)

'Citizen sensing'

- Participatory urban planning
- Place-aware social networking
- Distributed documentary – journalism
- Community-built histories, the new 'local library'

Common Application Style: Observation *Campaigns*

Real urban examples of citizen concerns (web based)

Bicycling to work – lack of adequate facilities (02-2256)
Cell phone use in cars (06-0002-S84)
Does red light photo program work (03-0354)
Fallen (public) fruit (fallenfruit.org)
Impact of lack of sidewalks (00-1168)
Items sold to children that resemble real 'bad' objects (05-2315)
Lawn estimated time-to-death without water (inspired by 03-2494)
Mobile phone Amber Alert (codeamber.org)
Neighborhood maintenance, visible decay (99-0827)

Partisan targets

Noise levels in different types of locations
Traffic at intersections (light timing, stop signs)
Park or street maintenance issues (uneven sidewalks)
Public transportation stop occupancy in LA
Power outage documentation – scope & time (05-1914)
Speed humps slowing traffic in neighborhoods (04-1281-S2)
Timelapse collage of a location
Water quality measurements (photograph simple indicators)

Numbers in parentheses are LA City Council file numbers.

Campaign mechanics

Post a *campaign* request

Issue / problem statement
Type of data needed
Sampling density, extents, other parameters
Geographic and temporal limits

Wait for people to agree to contribute

Offer coverage to take samples
Offer availability to classify / verify samples if necessary
Opt-in to submit location, receive SMS msgs triggering sampling

Campaign executes

System listens to published locations of citizen-sensors
Trigger sampling according to geographic + temporal coverage needs
Adjust windows, triggers (via SMS) to achieve coverage
Pass samples to distributed analysts who verify/classify
Accept and post (map, visualize) results

Closure

Once sampling period is over, analysis tools available
Allow challenge poster to remove invalid data points,
but show removals and link to removed data
Work on re-use of data in other campaigns

Motivations to participate

Network vouches for the context

Organized use by community partners

- Individual agreement with / interest in issues
- Disagreement with past campaign
- Gaining ability to post challenges of one's own

Simple APIs open intrinsic capabilities of the framework to 'mashups'

- Coverage entry / estimation / management
- Opportunistic triggering of sampling
- Distributed classification / verification
- Online tools for analysis

Concerns about participation: Privacy

Need for personal configuration and control of shared data

- Close to the sensor source; not on the backend
- Lessons from microdata release: Resolution control, blurring, subsampling, local buffering and filtering

Guidelines for Privacy and Selective Sharing

- Context of data should be verifiable to a resolution with which provider is comfortable; and as needed by application
- Policies for selective sharing should be implemented as an automated component of a sensing system.
- Decisions about data sharing depend often on location and time.
- HCI for configurability of privacy/security policies is critical (Bellovin)

Sensing Contexts Matter

- **Private Citizens, Private Spaces**
  - Personal applications
    Data strictly personal and citizens expect privacy (health monitoring)
  - Social applications
    Share data with a small circle of friends (Flickr)
  - Urban applications
    Citizens share data as part of city or state-wide project (blogs)
- **Private Citizens, Public Spaces**
  - Monitoring the public domain space by private citizens.

Data Integrity also a concern: Mediators

Physical Context and Sensor Data Validation

- Physical context information useful for validating integrity
- Aggregation can aid in verifying sensor data.

Mediators protect both data and contextual information

- protect at a network level through interposition, indirection, physical proximity
- protect statistically through aggregation, down-sampling, blurring, and other anonymization techniques

Activities

Slogging premise

citizen-initiated *sensing, publishing, sharing*

SensorBase.org

Urban Sensing Summit (Held May 06)

- UCLA, USC, UCI, UMN, Iowa State
- Nokia, Cisco, Disney, IBM, Intel
- Getty Conservation Inst., Mollenhauer, Metro Planning Report

CS219 Course (Held Spring06)

- Platform: Nokia 770/usb audio adapter/Bluetooth GPS; Maps and Earth

ecoPDA prototype development for Conservation International

- Biodiversity protocols
- Nokia n70/n80 based (SensorPlanet)

Selective sharing and context verification (NSF-FIND project funded)

- *mediator architecture, verified context tagging*
  app: participatory ***urban planning*** *tool.*

Integration with "backend" discovery (ESP) and Sensorbase

- *Ubicomp06 Demo.*

CS219 Projects

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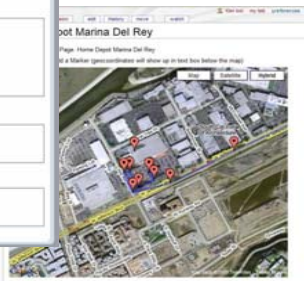
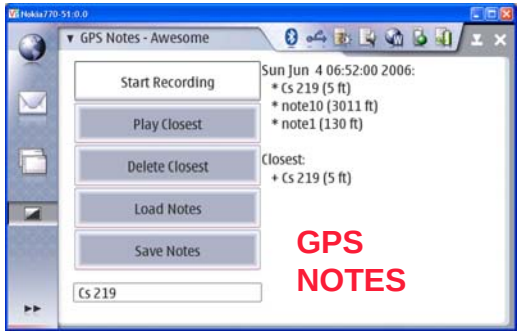
WIKITOUR

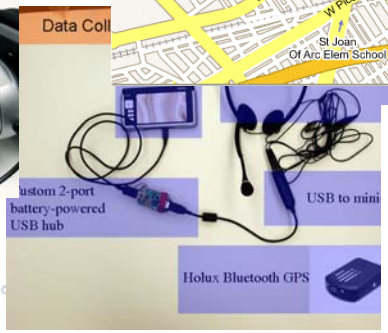


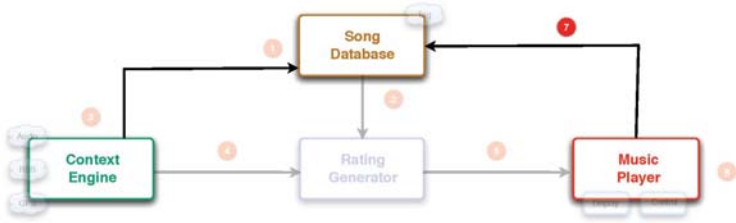
SOUNDSCAPE

GPS NOTES

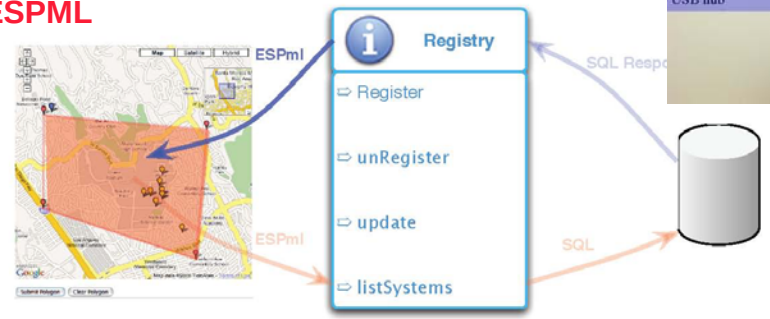


TAGGING RECORDER





ESPML



LIFETRAK

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