Coordinating Measurements for Participatory Sensing Applications

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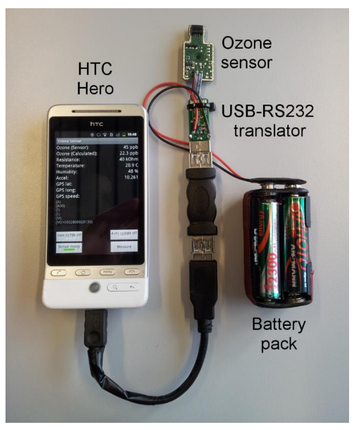
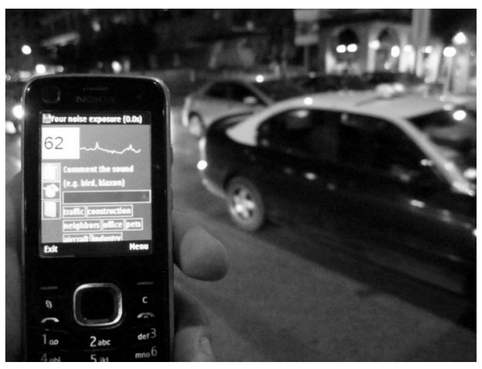
Introduction

Participatory sensing is becoming an effective and cheap tool for monitoring environmental phenomena.

Participatory sensing is about crowdsourcing sensory information via sensors carried by ordinary people(i.e. non-experts).

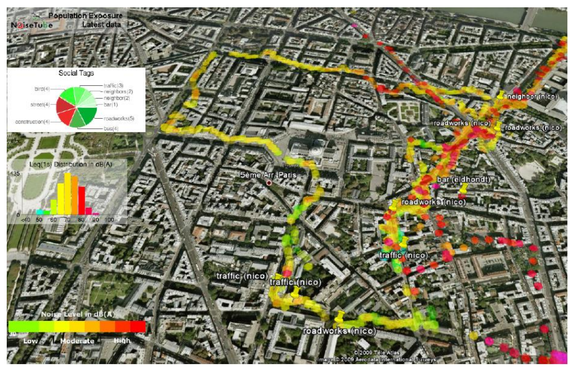
Sensor information include temperature, noise, radiation levels, light, humidity and gas concentration.





Problems in current participatory sensing applications:

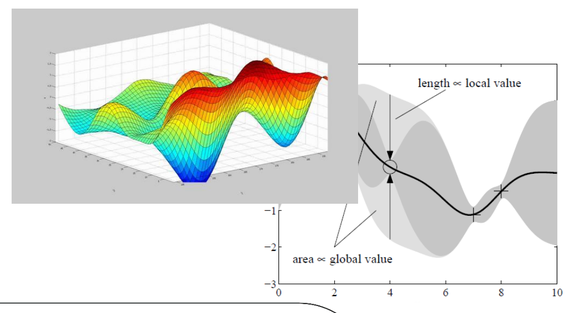
- Partial coverage of the areas of interest which results in **poor situational awareness**.
- Duplicate work which results in energy loss.

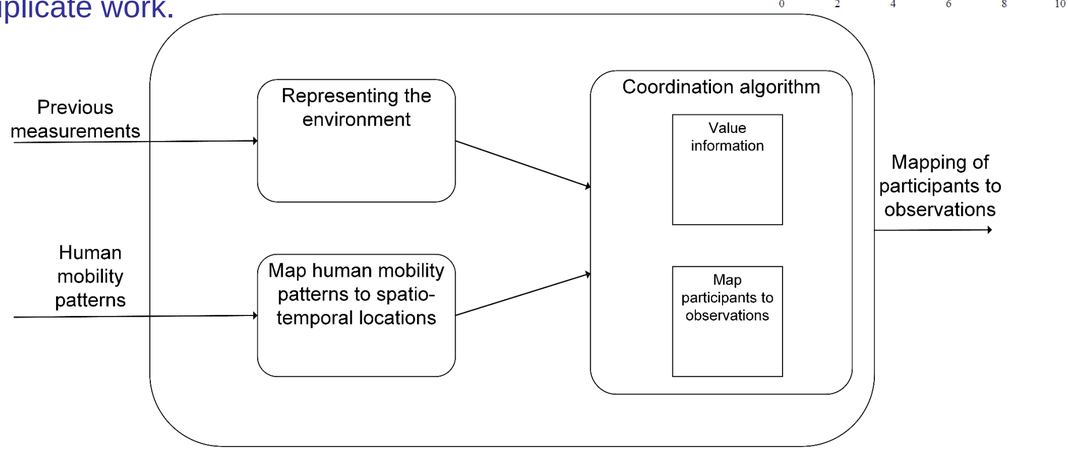


System Architecture

Aim

Provide algorithms for **coordinating measurements** in the participatory sensing setting for environmental monitoring in order to achieve better situational awareness and avoid duplicate work.





We use D-optimality Criterion to value the information at spatio-temporal locations.

$$I(X_B; X_A) = H(X_B) - H(X_B|X_A)$$

Use Gaussian Processes to model correlations over space and time.

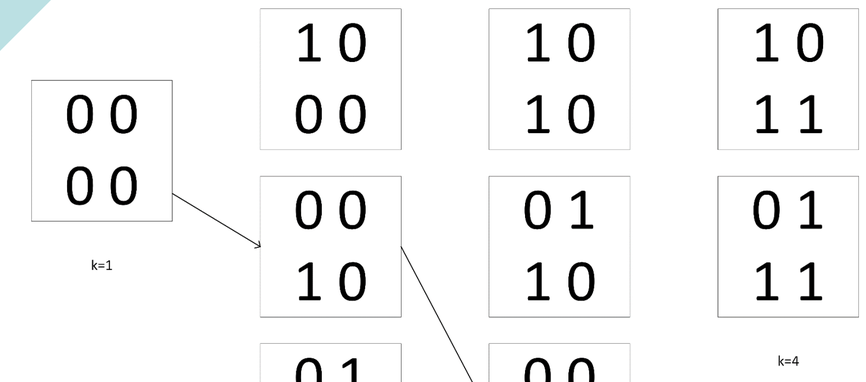
$$f \sim GP(0, K(\boldsymbol{x}, \boldsymbol{x}'))$$

Coordination Algorithm

Local Greedy Search (LGS) Algorithm

Step 1
- Start with a null binary matrix: No measurements at all.

Step 2
- Search for the single best improvement in the matrices in each iteration: Add bit by bit until no further improvement is achieved.



Assumptions:
- Human mobility patterns are known.
- Each observation is associated with a cost.

Example:
- 2 participants.
- 2 time steps.

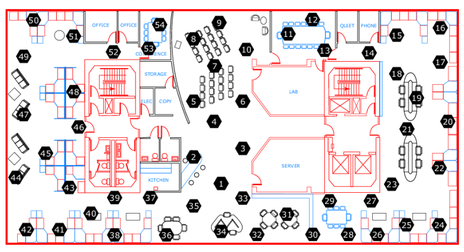
Experiments

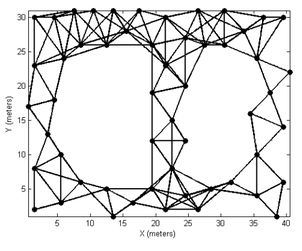
Benchmarks

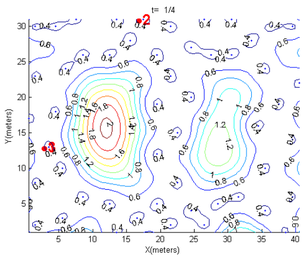
- Greedy algorithm: Take best decision at each time step
- Patrol: Take measurement at every time step.
- Exhaustive Search: Optimal policy

Simulation

- Real sensor data used.
- Synthetic mobility patterns.
- 4 time steps
- 3 participants







Key results

LGS is 83% **better** than the state-of-the-art greedy algorithm and takes 3.3% of the total time of the optimal algorithm.