ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

Sensorscope

Design Project - SIE 2012

Kévin André, Alex Bonvin

Encadrants EPFL: **Adrian Arfire**, **Prof. Alcherio Martinoli** (DISAL)
Encadrant externe: **Davis Daidié** (Sensorscope)

Gas field estimation - A challenge for mobile WSNs

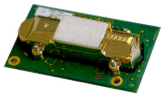
Context

The OpenSense project[1] aims at creating a community-based air pollution monitoring platform built around mobile wireless sensor networks (WSNs). Mobile sensors are placed on private and public vehicles and acquire pollutant concentrations over cities.

Mobile sensor networks present the main advantage of covering a larger area than static networks for the same number of nodes. Being an unusual method of acquisition, the reliability of mobile data is not well understood.

Our work focuses on the pilot phase of the OpenSense project in Lausanne.





Approach

• Monthly and hourly data aggregation over week days

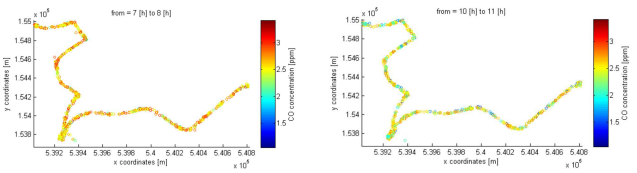
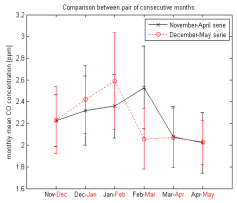


Fig. 1: Temporal structure is visible as morning commutes bring higher concentrations

• Why aggregate monthly?



	Nov - Dec	Dec - Jan	Jan - Feb	Feb - Mar	Mar - Apr	Apr - May
student's H	0	0	1	1	0	0
p - value	0.227	0.382	0.031	0.007	0.365	0.999

Fig. 2: The x-axis of the graph represents the succession of pairs of months that were compared at identical measurement locations.

The associated table shows the results of the (paired) student's test used to establish the significance of the difference in means between two successive months. An H-value of 0 means that the hypothesis of equal means is accepted, while a value of 1 indicates its rejection. We note that, even for the months of December and January, the test cannot reject the hypothesis of equal means, although the graph displays them as different. Such tests are thus useful for justifying aggregation.

• Filtering of data according to parameters impacting pollutant concentrations such as wind or rain.

Discussion

The main advantage of mobile data acquisition is the density with which measurements can be taken. Even if 1-D interpolation were able to reveal a spatial structure, it would not bring additional information since pollution measurements are collected with sufficient density (fig. 1 shows no gap where interpolation is necessary).

The applied low-pass filter showed promising results for the small subset on which we were able to apply it.

Objectives

Analysis of pollution data gathered over Lausanne, in particular their use for interpolation

• Measurements provided by one bus only ➔ mandatory **data aggregation**

• Applicability of interpolators such as Kriging: can a **spatial/temporal structure** be found ?

  • Temporally

  • 2-dimensionally

  • 1-dimensionally

• Reliability of **mobile data**

Results

Effect of filters on the significance of fluctuations of the concentration mean

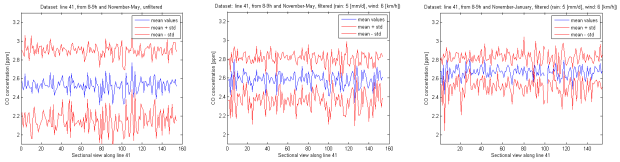


Fig. 3: No filter (left) vs. filter for wind, rain and week days (middle) vs. filter for wind, rain, week days and months. Fluctuations in mean become relevant compared to standard deviation.

Interpolation:

• Temporal interpolation is not useful: urban fields are too complex for instantaneous measurements to be usable as such (Fig. 3 shows high variability, due to many possible perturbations). Hourly means are needed but yield no temporal gaps.

• 2-D interpolation might not be appropriate: the studied pollutants are emitted mostly by vehicles. Concentrations too far from the streets are not correlated with vehicular emissions and thus cannot be interpolated.

• 1-D variogram fitting is unable to reveal a spatial structure

Quality of mobile measurements:

• Low-pass filter applied on mobile data. Promising results though not enough data to quantify it.

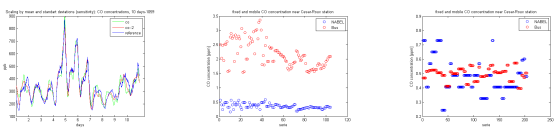


Fig. 4: Low-pass filter on static station (left), no filter on mobile data (middle) vs. low-pass filter on mobile data (right)

[1] *http://www.nano-tera.ch/projects/401.php*